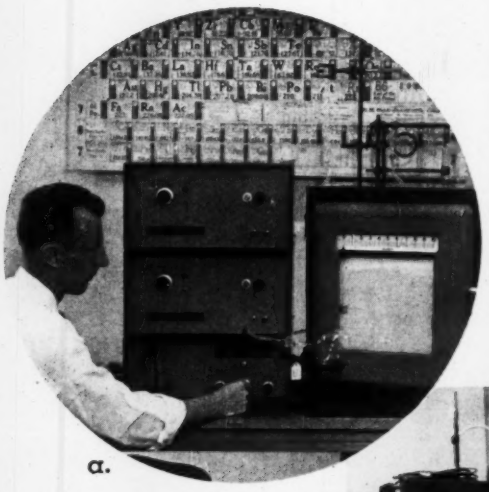
INSTRUMENTS and AUTOMATION

Including: Instrument Manufacturing • Journal of the SCMA • Simulation Council Newsletter



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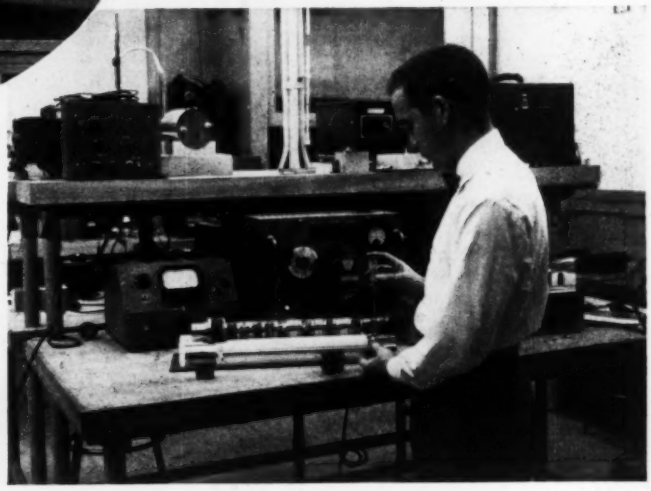


b.

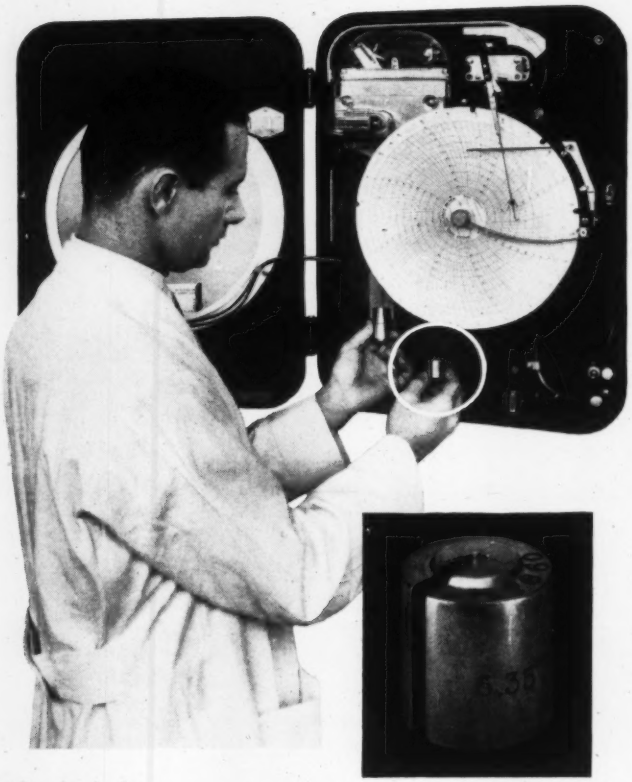
c.

DECEMBER 1957

HAGAN RING BALANCE FEATURES—NO. 3

CHECK CALIBRATION OR CHANGE RANGE IN MINUTES

without water columns—without disconnecting meter from line



The calibration of any Hagan Ring Balance meter can be checked —in minutes—by simply hanging the appropriate weight on the check weight rod. Similarly, range change over a seven to one differential range can be done with equal speed and accuracy.

In terms of instrument technician's time, you can easily figure how much this one feature of the Ring Balance will save you. And, you don't have to take a busy pipefitter away from other work to break connections.

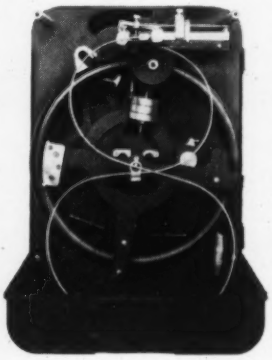
Ask your Hagan engineer to show you how easily range change and calibration checks can be made, using only the set of check weights supplied with each meter. Ask him, too, to explain some of these other outstanding features of the Hagan Ring Balance:

1. High sensitivity at low flows due to unique range calibration system. Full scale deflection at ½" WC.
2. Safe operation with rings rated at 2,500, 6,000, 15,000 psig. No gaskets, no stuffing boxes.
3. Sealing fluid density and level not critical. No eye-droppers.
4. Interchangeable ring assemblies for full scale ranges from 0.5" WC to 560" WC. Adjustment on any one ring over a seven to one differential range.
5. Wide range computation and/or compensation by means of built-in, easily checked mechanisms available on most models.
6. Pneumatic or electric transmission also available.

Bulletin MSP-141 describes these features and the new design of the Hagan Ring Balance meter case. ASK US FOR IT.

TIME SAVER—This shows how easily a Ring Balance can be checked. Note there are no two-story water columns—one man is doing the job—and the meter has not been disconnected from the line. In fact, Ring Balance can be checked at full static pressure if desirable.

The check weight is factory calibrated against a micrometer type manometer, and its equivalent in inches of water column is stamped on the side. The serial number of the meter to which it belongs is also stamped on the collar. A full set of calibrated weights is supplied with each meter.



Rear view of Ring Balance with cover plates removed. Here the test weights are in position on the test weight rod. Note accessibility of all parts for easy adjustment.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
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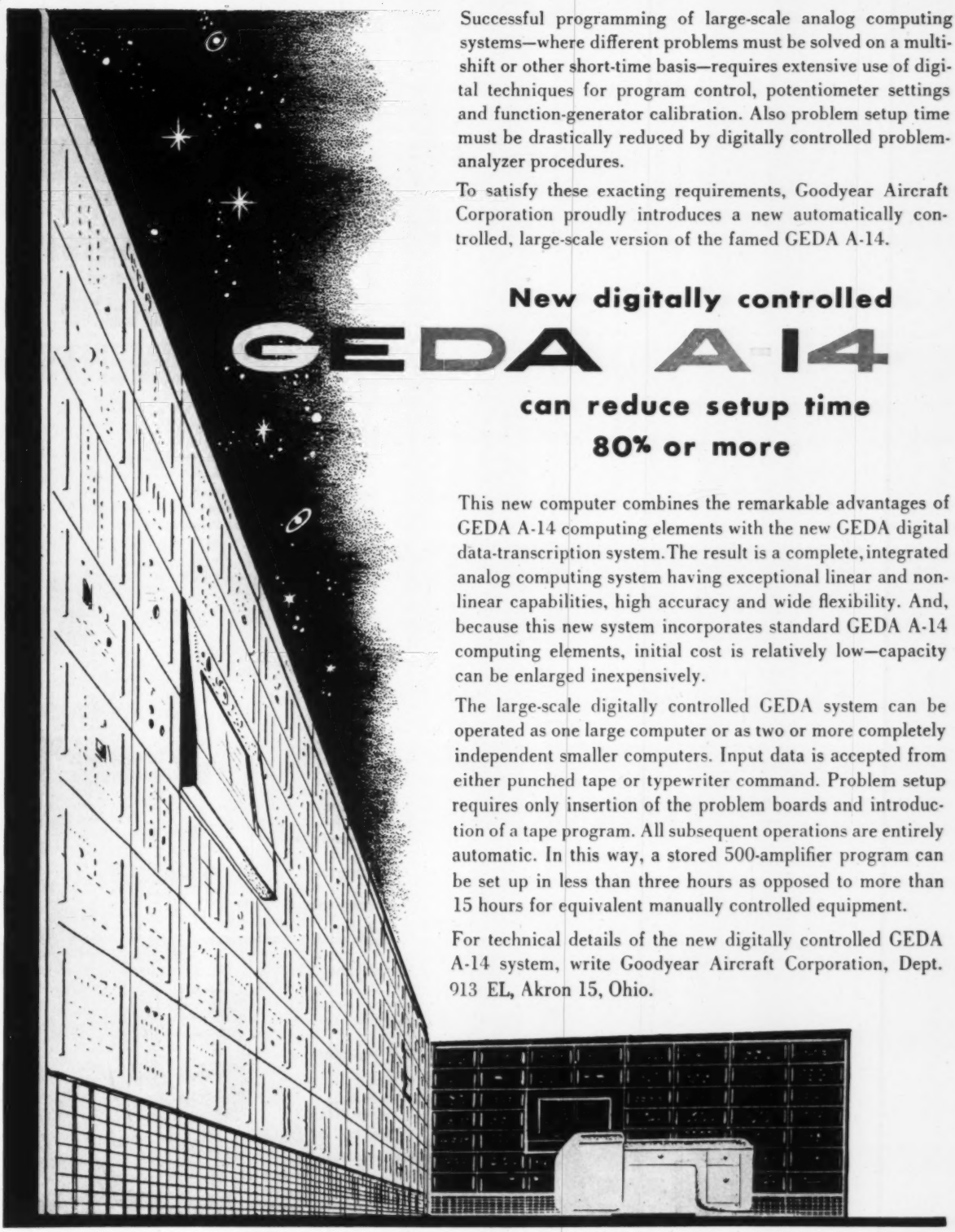
For more information circle 1 on inquiry card.



Successful programming of large-scale analog computing systems—where different problems must be solved on a multi-shift or other short-time basis—requires extensive use of digital techniques for program control, potentiometer settings and function-generator calibration. Also problem setup time must be drastically reduced by digitally controlled problem-analyzer procedures.

To satisfy these exacting requirements, Goodyear Aircraft Corporation proudly introduces a new automatically controlled, large-scale version of the famed GEDA A-14.

New digitally controlled

GEDA A-14

can reduce setup time 80% or more

This new computer combines the remarkable advantages of GEDA A-14 computing elements with the new GEDA digital data-transcription system. The result is a complete, integrated analog computing system having exceptional linear and non-linear capabilities, high accuracy and wide flexibility. And, because this new system incorporates standard GEDA A-14 computing elements, initial cost is relatively low—capacity can be enlarged inexpensively.

The large-scale digitally controlled GEDA system can be operated as one large computer or as two or more completely independent smaller computers. Input data is accepted from either punched tape or typewriter command. Problem setup requires only insertion of the problem boards and introduction of a tape program. All subsequent operations are entirely automatic. In this way, a stored 500-amplifier program can be set up in less than three hours as opposed to more than 15 hours for equivalent manually controlled equipment.

For technical details of the new digitally controlled GEDA A-14 system, write Goodyear Aircraft Corporation, Dept. 913 EL, Akron 15, Ohio.

GEDA ANALOG COMPUTERS

GOODYEAR AIRCRAFT

GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

For more information circle **2** on inquiry card.

a good rule to follow:

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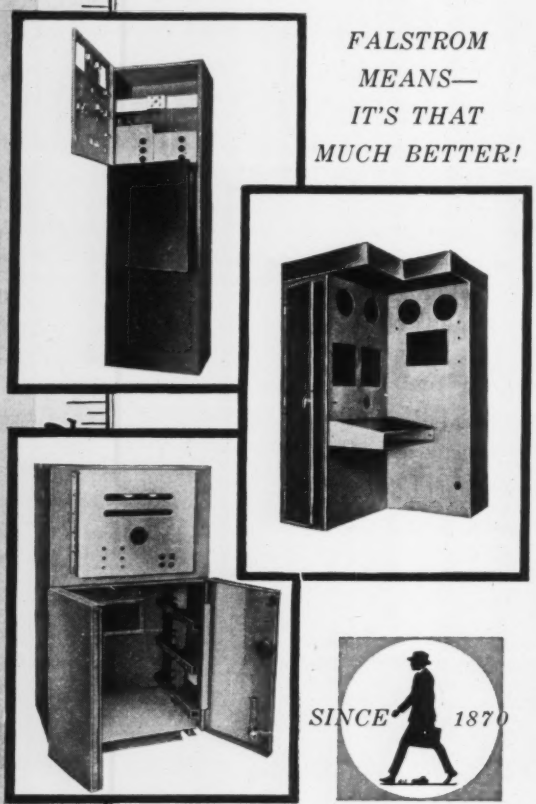

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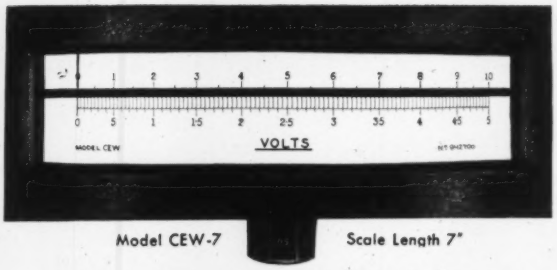

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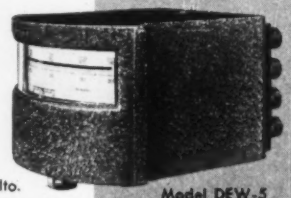

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INSTRUMENTS and AUTOMATION

EDITED FOR USERS OF MEASUREMENT AND CONTROL INSTRUMENTS

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December 1957

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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Letters to the editor

Editor, I&A:

In the October 1957 issue of *Instruments and Automation*, p. 1822, you published a letter from F. Kenneth Mayer of San Jose, California, asking about your Digital Automation Series and also about published material on mechanical translation. Would you permit me in reply to put in a plug for the little journal, *MT (Mechanical Translation)* which we publish three times a year at M.I.T? In it Mr. Mayer and others interested will find papers reporting on current work in this country, in England, and, to the extent we are able to get their contributions, in Russia.

The Moscow Institute of Foreign Languages publishes their own mimeographed *Bulletin for Machine Translation*, and the Russian journal, *Problems of Linguistics*, last fall had a series of articles on the subject. These publications are of considerable interest because they have as many people working on the application of computers to language translation as we do in the West.

The Proceedings of the VIIIth Congress of Linguists in Oslo last August and of the Georgetown University Round Table on Languages and Linguistics last April, both of which should be published soon, will contain papers on machine translation.

William N. Locke
Head of Dept.
of Modern Languages
Massachusetts Institute of Technology

Editor, I&A:

I am grateful for Dr. Locke's reply to my inquiry about mechanical translation. Recent events make its early perfection imperative. Frantic efforts are made to de-beep the sputniks but scant effort is made to learn the language of those who launched them. Many scientists assert that we will fall far behind in know-how if we do not keep abreast of technical advances made throughout the world. They say it would be worth the cost of $1.5 million to translate Russian papers already piled high in the Library of Congress, even if the greater percentage may be of no significance. A major prob-

Continued on page 2186

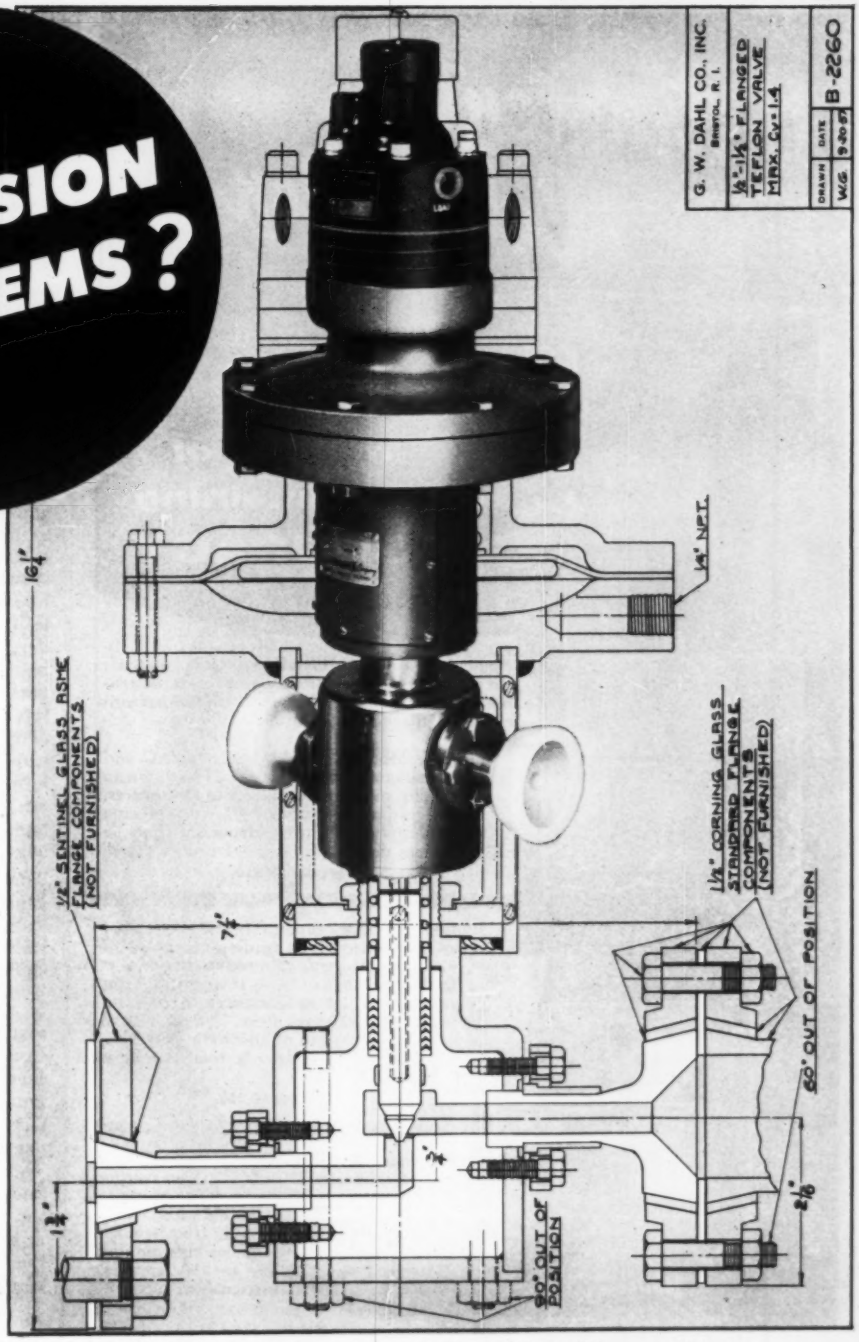
CORROSION PROBLEMS ?

To assist you in controlling the flow of a corrosive product, we offer the *ONLY* Control Valve that safeguards your product and itself with TEFLON.

The body, stuffing box, integral seat and internal ports are all precision machined from a solid block of TEFLON*, and encased in a stainless steel housing. The plug and stem are one, precision machined from TEFLON and reinforced with stainless steel. Spring loaded, TEFLON chevron rings maintain a tight stem seal.

The plug will be characterized and calibrated to meet your requirements within the following ranges, 0.003 minimum to 1.4 maximum Cv, with a maximum rangeability of 50 to 1. For throttling control the positioner is recommended but may be left off for on-off service.

*Other materials available.



All TEFLON components are indicated by white area above. The Valve is equipped with TEFLON end connections, machined for coupling to glass pipe. Other types of end connections are available upon request.

REPRESENTATIVES IN PRINCIPAL CITIES Write us for complete technical information, or for the address of our representative in your area.

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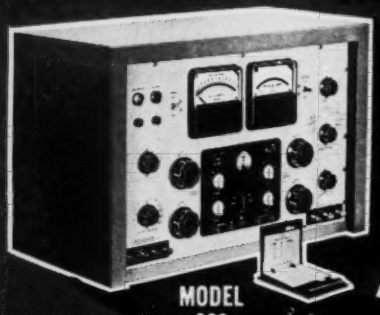
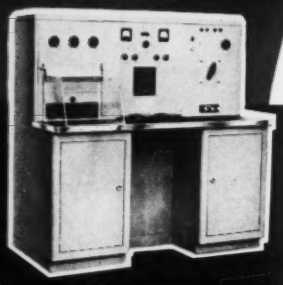
Instrument Calibration HEADQUARTERS



a modern method of maintaining ACCURACY

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.

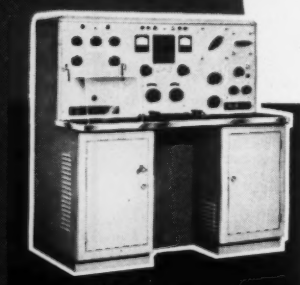


Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

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LETTERS—CONTINUED

Continued from page 2184

lem is that we have so few linguists who are technical experts.

Progress on mechanical translation has already shown its tremendous value in scanning foreign publications to ascertain which are sufficiently significant to justify the expense and effort of further study. This scanning service would save time and money by enabling our short supply of technical linguists to concentrate on works of the highest order. By rapid electronic means it can make instantly available valuable data which might otherwise be over looked or lost in undigested accumulation.

Further research in both mental and mechanical translation is needed to increase its efficiency. Dr. Hayakawa in *Language in Thought and Action* brilliantly cites the difficulties inherent in most translations which lead to further confusion and misunderstanding. Even speech translation in the UN assembly is by no means perfect. At the recent UNESCO conference on Asian-American relations, delegates deplored how few Americans can speak Asian languages and how textbooks and teaching methods are so out-of-date. In some languages the classical forms alone are taught which are as applicable to modern usage as a tourist boning up on Latin for a trip to Italy.

Intensified research in mechanical translation should serve to break the language barriers that inhibit worldwide mutual understanding so urgently needed today. Dr. Locke reveals that such research is in full swing in Russia, England and elsewhere. Electronic machines may yet contribute to our own future as much through applied linguistics as through devices for control and computation. The pioneering work of Dr. Locke and others in this field should receive the active support of all who desire a secure and expanding future for the instrument industry and the world.

F. Kenneth Mayer
San Jose, Calif.

Editor, I&A:

The title of your book *Electronic Circuitry for Instruments and Equipment* caught our eye in the recent issue of your publication.

A short time ago the writer used the word "circuitry" in correspondence and was criticized for so doing. He happened to be in New York shortly thereafter and with the aid of the librarians in both the electronics section and general reference

of the City Library we searched for this word in a number of dictionaries. Failing to find it, we made use of the Engineering Library of the Society of Electrical Engineers of New York and failed to find the word there. We have discussed "circuitry" with several electronic engineers and writers and find they use the word freely, but we can find no authority to help us prove that the word is a good one. Can you enlighten us.

George H. Schroeder
Technical Director
Marathon Battery Co.
Wausau, Wisc.

There are many suffixes in accepted use that do not appear in most dictionaries—"lilylike," etc. On page 59 of the US Government Printing Office Style Manual it states, "54. The compounding and hyphening of scientific terms are governed by scientific usage."

The use of the suffix "ry" or "y" to mean pertaining to is a common one—psychiatry, planimetry, etc. Hence use of the word "circuitry" as meaning pertaining to circuits can at least be rationalized by scientific usage if not justified by inclusion in standard dictionaries. The word is widely used; the first edition of the book "Electronic Circuitry" sold out its entire 5000 volumes and is now in its second printing.

Editor, I&A:

Sputnik was no surprise to me. In Germany I have lived much nearer to Russia than the U. S. citizen and I was always aware of the brilliant mind of these people, more brilliant than the Germans or British. What they lacked was interest for production. When I was in Russia in 1933 I saw that the methods of teaching engineering were much better than the German methods. At that time I reported to my company: "The Russians can build everything, if they want to, in the same quality as the best German products. But they are not interested in the intricacies of the best flushing system for a WC and other consumer goods."

Here, (in the USA) there is only interest for the dollar. A Wall Street stock broker told me once: "Who is Einstein? A nobody! He makes only $7000 per year." And another friend, a good lawyer, talking about one of his sons, George: "He is a very nice boy, but he is not very bright, he will be a scientist, sitting in a corner and inventing things." When in 1793 the French sentenced Lavoisier (who worked on chemistry and also as a tax collector) to death, the court was told that he was a great scientist. "The Republic does not need scientists" and his head was chopped off.

With the American attitude

Continued on page 2189

ONE HOOK CAN'T CATCH ALL FISH

One tape can't serve all recording needs in magnetic instrumentation

There are differences between pulse and carrier recording . . . therefore the tapes used in these systems must have different characteristics. Only in Soundcraft Instrumentation Tapes are these distinct and separate properties engineered into the oxide formulation. Soundcraft then adds two original processes — Uni-Level Coating and Micropolishing — to achieve the surface perfection found exclusively in the most advanced tapes of our time:

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RCCH oxide formulation gives "Type A" higher signal output and greater retentivity plus unique surface hardness for controlled tape wear rather than uncontrolled equipment wear.

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R14

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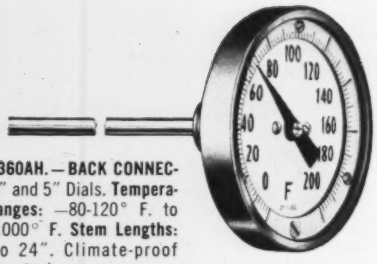

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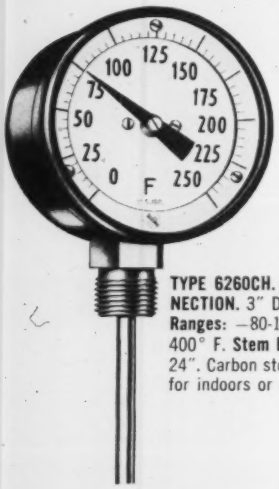
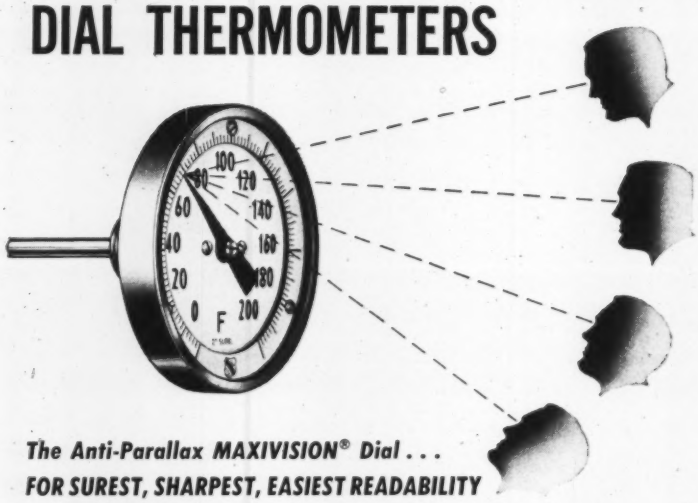


TYPE 6260CH.—BOTTOM CONNECTION. 3" Dial. **Temperature Ranges:** —80-120° F. to +50-400° F. **Stem Lengths:** 2½" to 24". Carbon steel case suitable for indoors or outdoors.

TYPE 6060AH. — "EVERY ANGLE" CONNECTION. 5" Dial. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.



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. . . Is Available Only In 'American' Thermometers

Nowadays fewer men are required in power and processing plants to inspect operations, so it is more important than ever to have observation points handy for them. 'American' Bi-Metal Dial Thermometers, installed at important check points, eliminate frequent trips to the control house. Inspectors can observe variations in process temperatures "on the spot" and take steps to effect corrections.

The economy of these thermometers goes far beyond the time-saving convenience of local indoor and outdoor readings. Their accuracy and utility contribute to lower costs. They provide the greatest sensitivity in bi-metal actuation. The low-mass single helix bi-metal coil is precisely centered in the stem to assure quick, accurate response to all temperature changes — to prevent the retard effect the coil can cause if rubbed against the stem wall.

The Maxivision dial is a split-level dial with pointer set on the same plane as the outside raised ring that carries the graduations. No perspective effect, no parallax! Readings are sure, sharp and accurate at a glance!

The availability of 'American' Bi-Metal Dial Thermometers in types with back, bottom or "Every Angle" connection permits selection to fit the conditions of each location. For example, the "Every Angle" type can be set at any point within 180° on two axes. Thus it is particularly recommended for installation above or below eye level or in close quarters where the types with fixed back or bottom connection would be impractical.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for assistance in selecting the types of 'American Bi-Metal Dial Thermometer best suited to your needs. He can provide separable sockets in al materials and sizes normally required.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle 9 on inquiry card.

LETTERS —CONTINUED

Continued from page 2187

towards science the country has to depend on the few enthusiasts who are different. But what do people think about these "different" people?

Dr. George Keinath
Consulting Engineer
Lachmont, N. Y.

Many have pointed out that the general atttitude of the average citizen toward teachers, engineers, scientists and "egg-heads" in general leaves a lot to be desired. There are two basic ways to change this attitude—(1) change the sense of values of millions of people or (2) raise the salaries of thousands of teachers and engineers. Either would work wonders for science.

Editor, I&A:

I have been a reader of your magazine since 1930 or 1931. At that time I found that I could understand about 75% of the magazine. Now, however, I'm lucky if I can understand 25% of it . . . Don't get the wrong idea; the 25% is still worth the $4.00 a year.

I would like some information on small gear trains . . . I am at present working on special air data computer components with as many as twenty passes between a combined motor and rate generator and the signalling autosyn.

Ernest V. Aspden
Pompton Plains, N. J.

The information has been sent. And your editors will try even harder to boost that 25% average.

Reader Inquiries

Transistors

Aircraft instrument mechanic seeks information on transistors including technical data, shop practices, etc. A-282

Flowmeter for Paint

Works manager of stampings manufacturer wishes to buy flowmeter calibrated in cc/min to measure flow of enamel through paint hose leading from supply tank. Range 0-300. To be used in series with variable-speed low-pressure pump. A-283

Special Pantograph

Design Engineer in petroleum industry is seeking special pantograph that reduces oil-well logs in one coordinate only. A-284

Urine Flowmeter

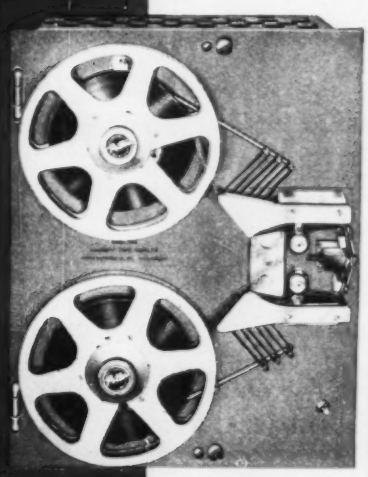
Urologist, instructor in medical school, seeks commercially available inexpensive device to record volume or weight of flow during urination in grams or cubic milliliters per second. A-285

NEW from Potter

no. 1 source...

peripheral equipment for digital computers

NEW speed... NEW versatility... NEW reliability! The Potter Model 906, using transistors, offers years-ahead design and performance for every tape handling function.



MODEL 906

TRANSISTORIZED MAGNETIC TAPE HANDLER

Potter

POTTER INSTRUMENT COMPANY, INC.
SUNNYSIDE BOULEVARD, PLAINVIEW, N.Y.
OVERBROOK 1-3200

FEATURES

- Completely transistorized
- Up to 150 ips
- As many as 4 speeds forward and reverse
- Rewind or search at 400 ips
- Vacuum loop buffer
- 3 millisecond starts
- 1.5 millisecond stops
- Tape widths to 1-¼"
- Up to 47 channels
- All functions remotely controllable
- Capable of continuous cycling at any frequency from 0 to 200 cps without flutter.
- In-line threading, end of tape sensing, and tape break protection

Other Potter products include Transistorized Frequency Time Counters, Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.

WRITE, WIRE OR PHONE FOR SPECIFICATIONS ON THE MODEL 906

For more information circle **10** on inquiry card.

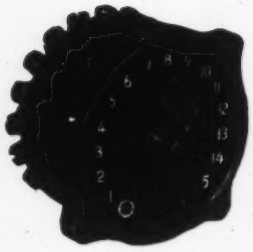
LEWIS SELECTOR SWITCHES
FOR RESISTANCE THERMOMETERS AND THERMOCOUPLE THERMOMETERS

EACH SWITCH HAS "OFF" POSITION PLUS NUMBER OF POINTS LISTED.

Points	Size	Switch Part Numbers: Thermocouple Type	Switch Part Numbers: 3 Wire Resistance-Thermometer Type
2	2″	11S2	36SR2
3	2″	11S3	36SR3
4	2″	11S4	36SR4
5	3″	10S5	37SR5
6	3″	10S6	37SR6
8	3″	10S8	37SR8
9	3″	10S9	37SR9
10	3″	10S10	37SR10
12	3″	10S12	37SR12
16	3″	10S16	37SR16
18	3″	10S18	37SR18
20	3″	10S20	37SR20
24	4″	27S24B2	38SR24
28	4″	27S28B4	38SR28
40	4″	38S2C	

(No. 38S2C is made with soldering-lug terminals)

2" SIZE



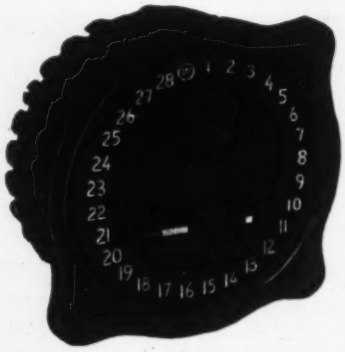
3" SIZE

SPECIAL SWITCHES

No. 37S6C2, Four "4 Point and OFF" thermocouple switches combined in one 3″ case.

No. 9S5, Single Pole, Four Point Instrument Switch in 1¼″ round case.

No. 44S4, Six Pole, Double-throw Instrument Switch in 2½″ round case, one hole mounting, ½-32 threaded bushing.



4" SIZE

DESIGNED FOR TEST WORK AS WELL AS FOR PERMANENT INSTALLATIONS. LEWIS SELECTOR SWITCHES ARE CONSTRUCTED WITH STURDY CONTACTS OF LOW RESISTANCE AND POSITIVE DETENT. THESE SWITCHES ARE SPLASHPROOF, DUSTPROOF AND ARE BUILT TO GIVE YEARS OF SERVICE.

THE LEWIS ENGINEERING CO.

Specialists in Electrical Temperature Measurements

NAUGATUCK, CONNECTICUT

For more information circle **11** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Defense electronics spending in fiscal 1957 will exceed $3.5 billion says EIA, compared to $2.8 billion in 1956.

Survey of 37 leading oil companies by Petroleum Week indicates that 84 large and medium-size computers are in use, about 50% in accounting, 50% in research; 38 more on order; committees at policy level are watching automation; all have made studies into computer uses.

Exports of electronic equipment and components in 1956 were above $330 million, compared to $250 million in 1955. However, total to date for 1957 is only $210 million, compared to $223 million for same period in 1956. Electrical instrument exports grew from $1 million in 1940 to $20 million in 1953; control valve exports from $2 million in 1950 to $10 million in 1953.

National Science Foundation reports that in fiscal 1953-54 nation's total R&D expenditure was $5.4 billion, or 1.5% of gross national product. About half of this was supplied by the Federal government, almost all devoted to defense. Universities performed less than $0.5 billion of this total. Less than half of this small sum went for basic research, more than half to applied research.

Sputnik means bigger military and research budget for 1958, leading to better business for electronic instrumentation. Emphasis on missiles and satellites will mean more instrumentation, more electronics, better business for instrument industry in 1958.

Present total of 414 VHF TV transmitter stations and 90 UHF is expected to increase to a total of 520 VHF and 120 UHF within two years.

Use of radio by utilities is expected to increase 2½ times in ten years, reports National Committee for Utilities Radio to FCC, as follows: 20% increase in 450-460 mc band, 40% in 30-50 mc band, 40% in 152-162 mc band.

National Science Foundation survey of 1000 academic institutions indicates 70,000 scientists and engineers employed by colleges and universities in 1953-54; about half were performing research on a full- or part-time basis.

New development is preparation of business forecasts by company personnel; larger firms are now assigning this job to company men reporting to management, says AMA Research Report #28. Factors watched most closely are (1) consumer buying power, (2) population statistics, (3) expansion reports.

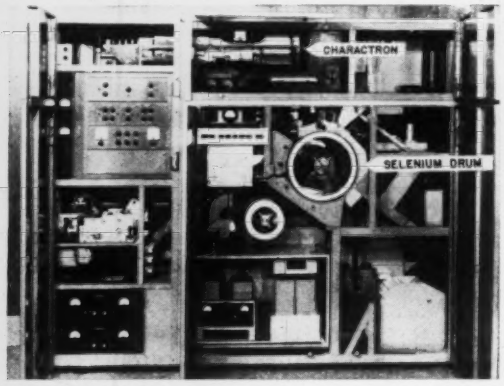
News

World's Fastest Printout Developed

Rimbach Tours Europe, Visits INTERKAMA

Texaco To Use First Process-Control Computer

ROCHESTER, N. Y.—S-C 5000 High-Speed Electronic Printer accomplishes an outstanding break-through in readout techniques, by combining the Stromberg Carlson Shaped-beam Charactron cathode-ray tube and the Haloid Copy-flo XeroX printer. Brilliant alphanumeric characters are formed on the face of the 7" charactron tube



at 4,680 lines per minute. These are projected onto the electrically charged surface of a selenium drum which is sensitive to light. Pigmented plastic powder is first picked up by the drum, then transferred to plain paper, gummed label stock, vellum or offset masters. Heat fuses the letters to dry permanent form, with the finished product coming from the printer at a rate of 65 feet per minute, 10,000 characters per second.

The device is compatible with a wide range of computers, using either on-line or magnetic tape input, through appropriate translating devices.

Commercial applications in preparing bank statements, billings, insurance notices, address labels (one million in an eight-hour day), high-speed communications reception, and missile and aircraft engine data reduction, are foreseen.

Both components of the S-C 5000 printer have been developed and used in other applications, and Stromberg-Carlson is prepared to accept orders for delivery in 6 to 9 months.

PITTSBURGH, PA.—Mr. Richard Rimbach, publisher of *Instruments and Automation*, recently toured France, Italy, Germany and England to survey new automation developments. While abroad, he was technical chairman of the session on process control at the First German International Congress and Exhibition of Measuring Instruments and Automation (INTERKAMA).

Mr. Rimbach is shown chatting with the Oberbuergermeister of Duesseldorf, Herr vom Felde, following the luncheon given by the mayor in honor of his guest. The banner between Mr. Rimbach and Herr vom Felde is embroidered with the Duesseldorf arms.

A complete report of Mr. Rimbach's trip will appear in a future issue of *Instruments and Automation.*

LOS ANGELES, CALIF.—Purchase of the first digital computer for fully automatic control of a petroleum refining process was announced by J. S. Worden, Vice President in charge of The Texas Company's Refining Department. Developed and manufactured by The Ramo-Wooldridge Corporation, Los Angeles, this computer, the RW-300, will control the petroleum refining process on a polymerization unit at Texaco's Port Arthur, Texas, refinery.

The RW-300 is the first digital computer engineered specifically for automatic control of industrial processes such as oil refining. It is also the first such machine which can be connected directly to conventional process instruments and controllers.

In announcing the purchase, Mr. Worden said, "With this unique computer, we are assured of a new degree of automatic control in Texaco's petroleum refining operations. We are confident that RW-300 will offer us increased plant output, greater quality control, and reduced operating costs." He said installation of the digital computer would not reduce the number of employes required to operate the polymerization unit.

The polymerization unit combines light hydrocarbon gases into high-octane blending components for gasoline. Present control of the process is handled by conventional instrumentation. Operators must visually check many instruments, perform certain calculations, and then adjust the necessary control instruments, valves, pumps, and compressors on the unit. Because of the complexity and changeable nature of the process, it is difficult for human control to achieve maximum production and quality at minimum cost.

Circle **12** on inquiry card.——→

Get Your Own *B-NOBATRON!*

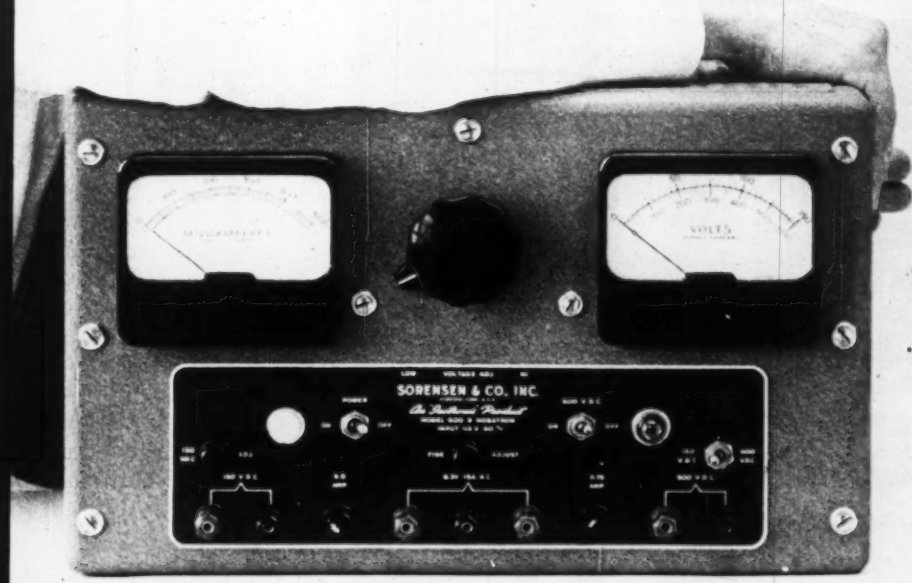
Multi-purpose B-Power Source Available in Five Models, Ranging from 300 to 1000 VDC Tops; Low Ripple, Accurate Regulation; Provide Filament and Bias Current in Addition to High Voltage Output.

Here's the economical and lasting answer to B-Power supply needs for nearly every laboratory, and many industrial operations. Nobatrons are built to last, and serve without maintenance. Damage to the Nobatron and its load is prevented by input and output fuses. Five models offer ranges of: 0-300 VDC, 0-325 VDC, 0-500 VDC, 0-600 VDC, and 200-1000 VDC. All but the largest model deliver 6.3 volts for filament supply and all but the 300-B and 1000-BB offer 0-150 volt regulated bias.

Regulation accuracy is within a maximum tolerance of 0.5%*, and ripple is held to five millivolts RMS or below (except for 20 mv. maximum on the 200-1000 VDC model). Input range is 105 to 125 VAC, with frequency of 50, 60, or 400 cycles. B-Nobatrons may be used in either cabinet or rack mountings, and are a handsome contribution to their quarters. Your local Sorensen representative will be glad to tell you all about these B-Nobatrons. Write directly for technical data, to

SORENSEN & COMPANY, INC. Richards Avenue, South Norwalk, Connecticut

**Only 0.15% maximum variation on the 0-300; and 0.25% on the 0-600 models.*



SPECIFICATIONS

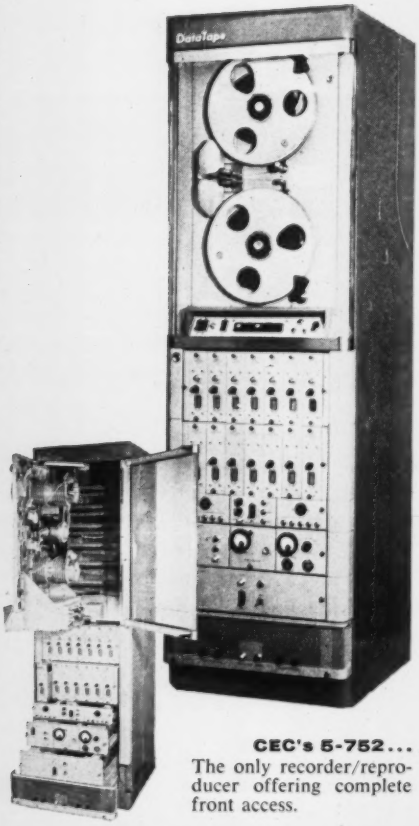
Model	300B*	325BB	500BB	600B	1000BB
Output Voltage VDC	0-300	0-325	0-500	0-600	200-1000
Output Current Ma	0-150	0-125	0-300	0-500	0-500
Regulation Accuracy	±0.15%**	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max.	20 max.
Bias Supply (VDC)	—	0-150	0-150	0-150	—
Max. Bias Circ. Imp. (Ohms)	—	25000	25000	50000	—
Max. Int. Imp. (Ohms)	2.0	2.0	2.0	2.0	2.0
AC Voltage (CT Unreg.)	—	6.3/10 amps	6.3/10 amps	6.3/15 amps	—
Filament Voltages (Unreg.)	6.3 at 5 amps, series or parallel (two outputs)	—	—	—	—

**may be connected positive or negative, in series or parallel*
***or ±0.3 volts, whichever is greater*

Sorensen

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

DataTape



CEC's 5-752...
The only recorder/reproducer offering complete front access.

standard of the missile range

CEC's MAGNETIC TAPE RECORDER/REPRODUCER

Selected in competitive tests for Air Force and Navy ranges... meets IRIG Specifications...

Simplify your data problems... get instantaneous playback with CEC's new 5-752 RECORDER/REPRODUCER SYSTEM. Handles Analog, PDM, and FM signals... provides up to 14 tape tracks for simultaneous recording and reproduction of separate signals on one-inch tape. Features CEC all-metal surface magnetic heads. Constructed to meet MIL-E-4758A. For complete data, contact your nearby CEC field office, or write for Bulletin CEC 1576–X9.

TYPICAL APPLICATIONS

Telemetering from Missiles and aircraft, including FM sub-carrier telemetering • Wind-Tunnel Testing • Jet and Rocket Engine Testing • Studies of Shock and Vibration • Mobile and Stationary Structural Testing: ships, trains, etc. • Static and Dynamic Testing: airframes and components • Sound Measurements: all types of analyses, including sonar, medical research.

DataTape Division

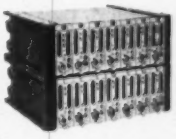
Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena 15, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

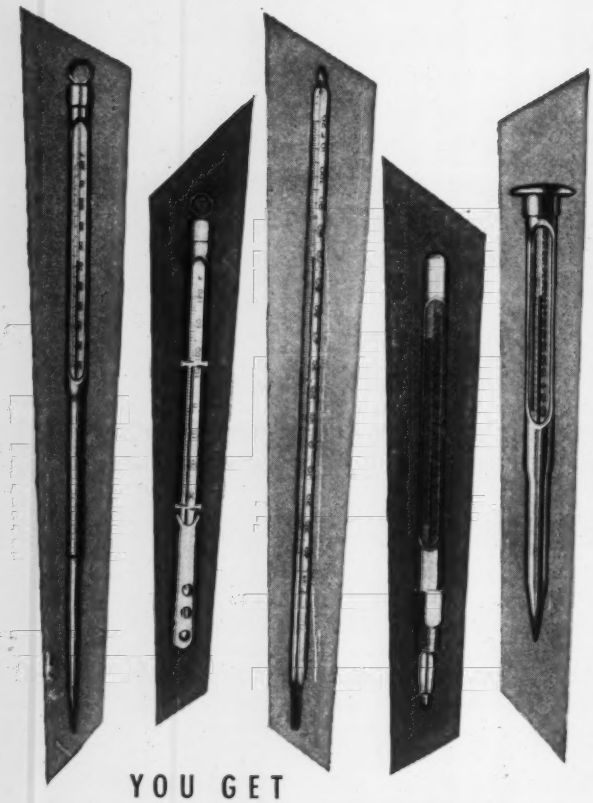
For precision in-flight recording, or wherever small size and portability are paramount, DATATAPE RECORDER provides up to 14 tape tracks. This compact recorder provides complete compatibility with the 5-752, guarantees accurate performance under severe environmental conditions (MIL-E-5272A, Proc. 1), and operates at extremely high temperatures to 100°C.

CEC's 1-001 Amplifier Case houses seven record amplifier modules in the smallest package on the market today. Rugged construction provides rigid mounting of modules. Coolant air is provided for operation up to 100°C. Stringent environmental specifications are met without the use of shockmounts.



10-12 oz. Miniature Record Amplifiers feature printed wiring, combination subminiature-tube and transistor circuitry, modular construction, and high-temperature operation to 100°C. Aluminum die-cast packages, 6¼" long by 3¼" high and 1⅜₁₆" wide, provide FM, PDM, and Analog recording.

For more information circle **13** on inquiry card.



YOU GET

dependability PLUS

WITH MOELLER TEST THERMOMETERS

because our business is the design and manufacture of temperature measuring instruments—and has been since 1867. Moeller Test Thermometers are guaranteed for permanent accuracy and are made according to specifications set forth by the United States Government, A.S.T.M., and other Societies and Associations. ***Mail the coupon today for descriptive literature on Moeller Test Thermometers.***

MOELLER INSTRUMENT COMPANY 132nd ST. and 89th AVE RICHMOND HILL 18, N. Y.

Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 800 on Moeller Test Thermometers, Hydrometers, Temperature and Hydrometer Conversion Tables.

NAME .....

FIRM .....

ADDRESS .....

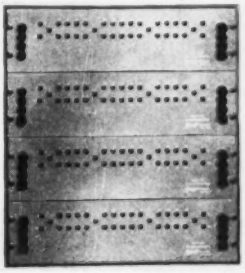
CITY ..... ZONE ..... STATE .....

For more information circle **14** on inquiry card.

News Bits

MINNEAPOLIS-HONEYWELL's Valve Div. has supplied two giant control valves to Philadelphia Electric's Edison steam plant. The 16″ valves stand 9½ ft high, weigh 2 tons, and can handle up to 400,000 lb of 160-psig steam at 450° F.

◄ M-H Giant Valve



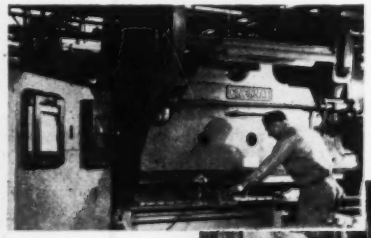
EPSCO Delay Line

What is believed to be the world's longest lumped constant delay line has been manufactured by **EPSCO, INCORPORATED,** to meet specific requirements of an auto-correlation application.

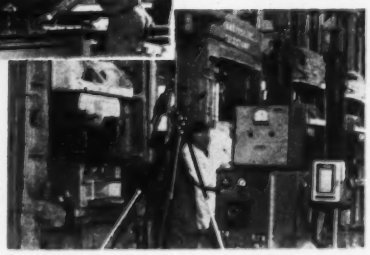
GENERAL ELECTRIC'S Communication Products Dept. is installing a new high-frequency microwave system which will provide Gulf Power Co., Pensacola, Fla. with central control over a 750-mile transmission network.

Titanium Forming

• Using a **GENERAL ELECTRIC** Reactrol Control, a **LEEDS & NORTHRUP** Temperature Controller and a 50 KVA resistance heating transformer, the Martin Co. has developed a special Power Pac, which makes for greater efficiency in resistance-heating titanium. The proportional type controllers of the unit maintain a much closer temperature control than is possible with on-off controllers, thus proving highly satisfactory for drop-hammer forming.



◄ Titanium Forming at Martin



Republic uses Infrared ►

• Republic Aviation Co. has solved the problem of titanium-sheet forming with a "Servotherm," infrared pyrometer manufactured by **SERVO CORP. OF AMERICA,** which measures the heat radiated from a heated body while a **GENERAL ELECTRIC** recorder keeps the record.

TECHNIQUES and DEVELOPMENTS in oscillographic recording

FROM

SANBORN

CIRCUIT DESIGN AND TYPICAL USES OF THE "150" CARRIER PREAMPLIFIER

One of the most frequently used plug-in front ends for Sanborn 150 Series oscillographic recording systems is the Model 150-1100 Carrier Preamplifier, since with it a "150" system can record such variables as force, temperature, strain, pressure, displacement, velocity, flow, acceleration — or any variable which can be expressed as a suitable input signal by a transducer. The "1100 Carrier" will operate with a variety of different transducers and bridge circuits, which will be mentioned later on.

In the block diagram (Fig. 1),

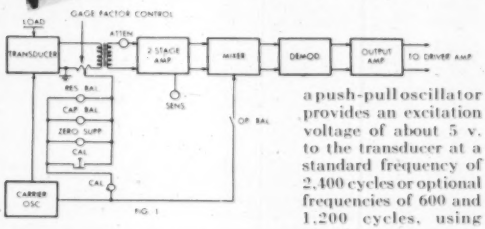


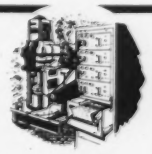
FIG. 1

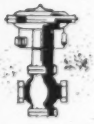
a push-pull oscillator provides an excitation voltage of about 5 v. to the transducer at a standard frequency of 2,400 cycles or optional frequencies of 600 and 1,200 cycles, using plug-in components. This excitation voltage also feeds the Balancing, Calibration and Zero Suppression circuits. (The Balancing controls allow correction of resistive and reactive signal leakage from the transducer, so that at zero load the net signal to the Preamplifier is zero. The Zero Suppression feature permits bucking out a large static load so that a small part of the load can be expanded over the full recording chart. The Gage Factor control allows the zero suppression range to be made equivalent to some convenient transducer load, or the full load rating of the transducer, and also causes the calibration signal to represent 2% of that load.) Transducer output is fed to the transformer through the Gage Factor potentiometer, across which the Balancing-Calibration-Zero Suppression circuits develop a voltage effectively in series with the transducer output. The mixer receives a suppressed carrier AM signal and re-inserts a carrier component, to make its output a conventional AM signal whose modulation represents the transducer load. The modulation signal (whose amplitude and polarity represent magnitude and direction of transducer output) is recovered by the demodulator and fed to the output amplifier, which in turn excites the Driver Amplifier and recording galvanometer of a "150" system.

Transducers which may be used with the Carrier Preamplifier include strain gage half-bridges or full-bridges, commercial resistance or reactance bridges, differential transformers and resistance thermometer bridges. The transducer chosen should provide at least 18.0 microvolts per volt of excitation at the minimum load to be recorded, for a one cm. deflection; impedance should be 100 to 1000 ohms. With strain gages, normal operation provides sensitivities of 50, 20 or 10 micro-inches per inch for each cm. on the recording, depending on the number of active gages. With resistance thermometers, if 1°C. or 2°F. per cm. stylus deflection is sufficient sensitivity, the user can construct his own resistance thermometer by including a 3 ohm coil of copper wire in one arm of an equal arm 100 ohm bridge.

Helpful information about the use of transducers with the 150-1100 Preamplifier is contained in the following Sanborn RIGHT ANGLE articles (reprints on request): Coupling Differential Transformers, Aug. and Nov. 1956; Filter Networks for use with Force Dynamometers, Nov. 1956; Calibration with 1-, 2- or 4-arm Strain Gage Bridges, Aug. 1955; Theoretical and Actual Applications of Bridge Circuits, May and Aug. 1954.

Wing flutter recording to infrared research . . . with the versatile "1100 Carrier"





Today, Carrier Preamp-equipped Sanborn "150" systems are being used for frequency response tests of process control system components; to record shaft deflections of fluid mixing equipment; in infrared research . . . vehicular traffic studies . . . submarine hull vibration measurements. Applications are limited only by the transducers available.

These are applications of only one "150" front-end; eleven more interchangeable, plug-in Preamplifiers increase the scope of Sanborn oscillographic recording systems to meet an almost infinite variety of research, production and field testing requirements. All Sanborn "150" direct writing systems record inkless traces in true rectangular coordinates; all provide 1% linearity; Basic Assemblies — equipped with your choice of Preamps — are available from one- to eight-channels, packaged in vertical cabinets, portable cases, or specially modified housings.

Technical data and help with your oscillographic recording problem are always available from Sanborn.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman St., Waltham 54, Mass.

For more information circle **13** on inquiry card.

You don't have to be over 21

to install and maintain

a Fenwal temperature indicating controller

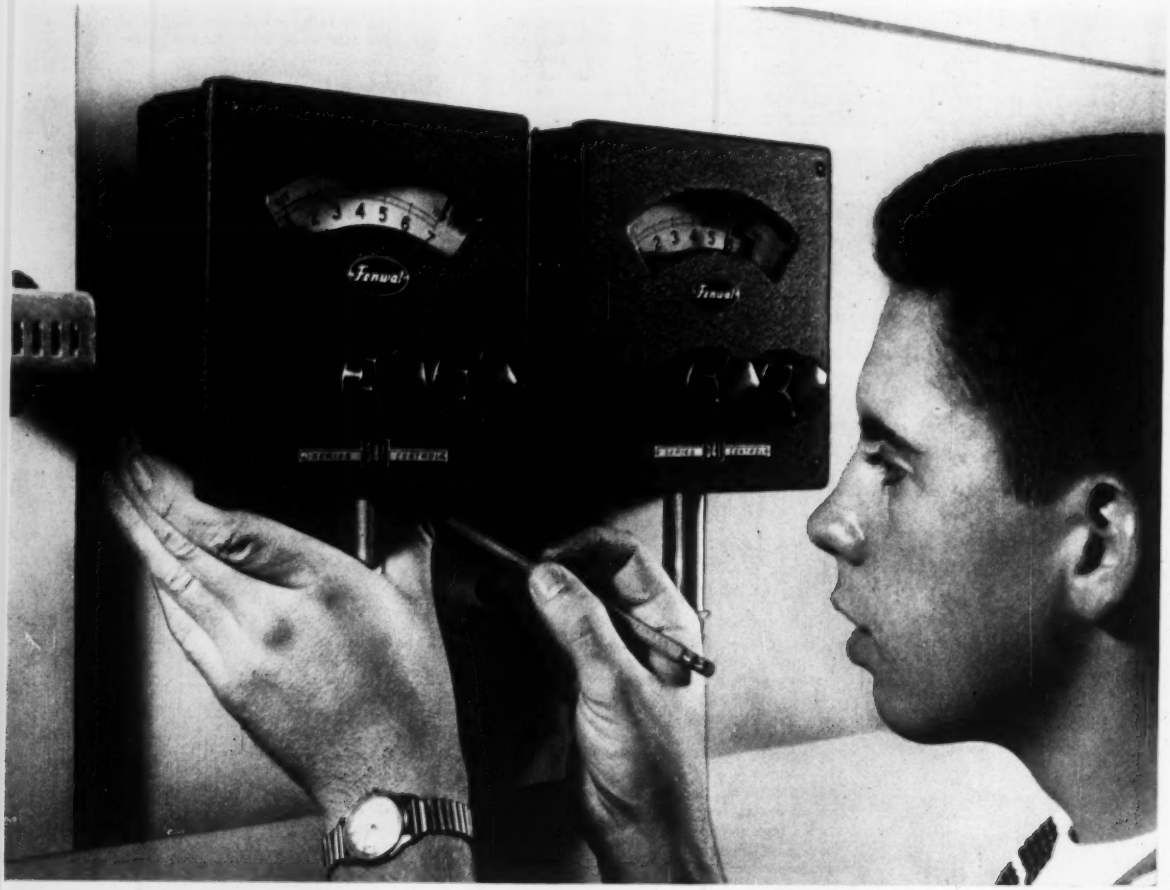
It really is a cinch for an untrained person to install and maintain Fenwal's 541 Temperature Indicator Controller. You don't even have to open the case to adjust it — even its snap switches can be easily replaced without disturbing the internal mechanism. *It's simple!*

In Fenwal's 541 all moving parts are in opposition — wear on one is automatically compensated for and the controller's high accuracy remains unchanged! *It's reliable!*

You can take your choice of temperature range, bulb styles, and one or two circuit controls, current ratings — even the color of the housing. There are literally hundreds of adaptations that can be made from stock! So you get a tailor-made, fit-to-order controller at a competitive price! *It's versatile!*

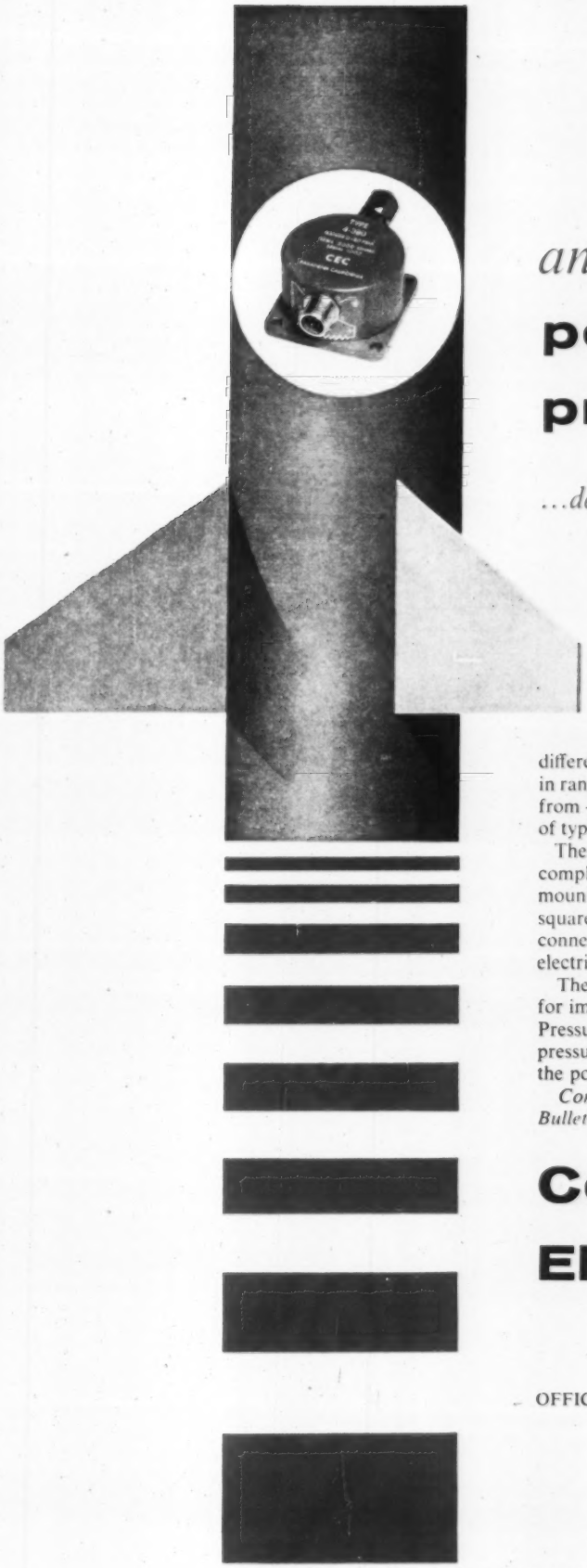
Drop us a line at Fenwal Incorporated, 3612 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-139 or our sales engineer, whichever you want.

This is our dual circuit model (we've got hundreds of others) which has two snap switches, each with a set point indicator, that actuates two circuits at pre-set temperatures. Housing in all Fenwal 541's meet NEMA and JIC specifications.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

For more information circle 14 on inquiry card.



announcing **CEC's potentiometer pressure pickups**

...designed for missile applications

Far superior in resistance to shock and vibration, the extremely rugged Type 4-380 Potentiometer Pressure Pickup is ideal for missile operation in a high-vibration environment. It is designed for absolute and differential pressure measurements of non-corrosive fluids in ranges under 100 psi . . . operates at temperatures from −65 to +200 F. It is approximately one-half the size of typical potentiometer pickups on the market today.

The new Type 4-380 weighs approximately 7 oz. Packaged complete with a flange base, it can be bolted directly to a mounting plate. Size of the mounting flange is 2¼" square; pickup height is 1⅝". A miniature, threaded connector is supplied for easy cable connection. All fittings, electrical and pressure, are parallel to the base.

The inherently high-level d-c output eliminates the need for impedance-matching or signal-amplifying equipment. Pressure fluid is admitted directly to a force-summing pressure capsule—remains external to the potentiometer system.

Contact your nearby CEC field office, or write for Bulletin CEC1604-X3.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **17** on inquiry card.

HAGEN
Synchronous motors

Speeds of 1800 to 1/6 RPM

Single direction — Reversible

Here is the most powerful, compact synchronous motor for its size. Ideal for use in industrial applications that require a motor of over-all size that is between the "clock" and fractional horsepower types.

Hagen Synchronous Motors are precision built throughout. Construction features a die cast housing, hobbed pinions and gears and bronze bearings throughout. Laminated rotor construction produces exceptionally high torque.

Hagen Synchronous Motors are available in five models. Standard motors may be mounted in any position. Coils are available for 24, 115, 230, 440 and 550 volts. Write for complete descriptive literature and performance data.

HIGHLY DESIRABLE FOR USE IN:

- TIMERS
- CHART DRIVES
- DISPLAYS
- INSTRUMENTS

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Moline, Illinois
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☐ Please send free Bulletin No. 1055 featuring Hagen Synchronous Motors

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **18** on inquiry card.

Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange

	Price Range For 1957 Thru November 15th		Price As Of November 15
	High	Low	
American Meter	34 1/8	26 1/8	29 - 30 (1)
Aro Equipment	22 7/8	14	14 1/8
Belock Instrument	13 5/8	8	8 3/8
Benrus Watch	8 1/2	6 1/8	6 5/8
Breeze Corp.	8 3/8	3 5/8	5 3/4
Barry Controls B	12 3/4	5 1/8	5 - 5 1/2 (2)
Clark Controller	34	14 3/4	16
Clarostat Mfg.	5 -	2 1/2	3 3/8
Clary Corp.	4 7/8	2 3/4	3 1/8
DuMont Laboratories	6 1/8	3	3 1/4
Dynamics Corp. of America	7 5/8	2 5/8	3
Electronics Corp. of America	12 7/8	5 1/2	6 1/2 - 7 (3)
El-Tronics	3 7/8	1 1/2	2 1/4
Fairchild Camera & Instrument	27 3/8	16	19 1/4
Globe-Union	20 3/4	16 5/8	17 3/8
Haseltine Corp.	44 1/2	29 3/4	34 3/8
International Resistance	6 1/8	3 7/8	4 1/8
Lear, Inc.	8 3/4	4 1/8	5 3/8
National Research	26 5/8	12 1/8	13 1/4
Neptune Meter	33 1/2	21	20 3/4
New Haven Clock	9/16	3/16	1/4
Norden-Ketay	11 3/4	5 1/4	7 3/8
Nuclear Corp. of America "A"	2 1/4	3/4	1 1/2
Pneumatic Scale	25	19	17 1/2 - 19 (4)
Servo Corp. of America	8	4 1/2	5
Servomechanisms	12 5/8	6 1/8	8 1/8
Wallace & Tiernan	33 7/8	23 1/4	25
Waltham Prec. Inst. Co.	2 1/4	1	1

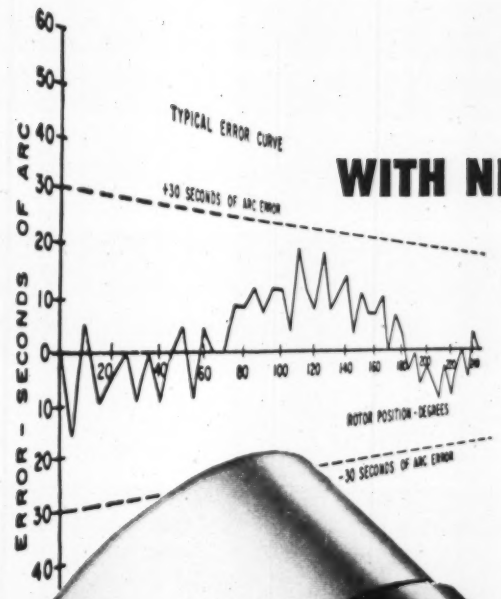
(1) Not Traded - Bid - Asked
(2) Not Traded - Bid - Asked
(3) Not Traded - Bid - Asked
(4) Not Traded - Bid - Asked

New York Stock Exchange:

	Price Range For 1957 Thru November, 15th.		Price As Of November 15th
	HIGH	LOW	
ACF Industries	64 7/8	39 1/4	42 3/4
Aeroquip Corp.	31 3/8	19 1/8	22 1/2
Allis Chalmers	36 1/4	24 7/8	26
American Chain & Cable	64 1/4	39 5/8	43 1/4
American Machine & Foundry	43 3/4	29 1/8	33
American Machine & Metals	58 3/4	41	49 1/8
American Optical	37 7/8	30 3/4	32 7/8
American Tel. & Tel.	179 7/8	160	165 1/2
Beckman Instruments	47 3/4	25 1/2	26 7/8
Bell & Howell	50 1/2	36 1/2	38 3/4
Bendix Aviation	66 3/4	42	49
Boeing Airplane	61 1/8	29	38 5/8
Bullard	29 1/8	11 1/2	11 5/8
Bulova Watch	21	12 7/8	13 7/8
Burroughs	52	30 1/8	31 1/8
Carborundum	51 1/4	28 1/4	33 1/8
Cincinnati Milling Machine	50 1/2	27 3/4	28 1/2
Clevite	25 1/2	17 1/8	18 3/4
Columbia Broadcasting "A"	36 1/8	23 1/2	26
Consolidated Electronics	35 1/2	18	18 5/8
Cornell Dubilier	27 1/2	14	15
Corning Glass	106 1/4	57 1/4	75 1/4
Curtiss-Wright	47 3/8	29 1/4	30 3/8
Cutler Hammer	64 3/4	38 1/2	43 3/4
Consolidated Electrodynamics	54 3/4	25 1/8	32 1/4
Daystrom	47	27 1/2	34
Douglas Aircraft	91	50 5/8	69 1/2
Eastman Kodak	115	81 3/4	96 3/8
Faton Manufacturing	64 1/4	40 3/4	42 3/4
Electric Auto Lite	40 3/8	28 5/8	31 5/8
Elgin Watch	14 1/8	7 3/8	7 3/4
Emerson Electric	34	22 1/8	25 3/4
Food Machinery & Chemical	65 1/4	42 3/4	44 3/4
Gamewell	36 1/2	20	21 1/2
Garrett	54	23 1/4	28 3/4
General Dynamics	68 5/8	46 3/4	59
General Electric	72 3/8	52 3/8	60 7/8
General Instrument	6 1/8	4	5 1/4
General Mills	69	56	56 3/8
General Precision Equipment	47 1/4	30 1/4	37 1/2
General Railway Signal	34	19 1/2	24
General Telephone	45 1/4	36 1/4	40
General Time	30 1/2	17 1/4	18
General Tire & Rubber	29 3/8	22 1/8	28 1/2
International Business Machine	376 1/2	270 1/2	300
International Tel. & Tel.	37 3/4	25 3/4	26 1/4
ITE Circuit Breaker	50 3/8	33	40 7/8
Lockheed Aircraft	57 1/8	26	36 1/4
Litton Industries	56 5/8	29 1/2	39 1/2
Magnavox	44	26 1/4	31 3/4
Minneapolis-Honeywell	131	73 1/2	80 1/2
Minnesota Mining & Mfg.	101	58	76 1/8
Motorola	51 3/4	35 3/4	44
Mallory	50 1/4	27 3/4	26 3/8

SYNCHROS

WITH NEW STANDARDS OF ACCURACY



KEARFOTT

NEW SIZE 25 SYNCHRO is accurate to 0.5 minutes of arc. It requires no external compensating devices. Available as transmitters, control transformers, differentials and resolvers.

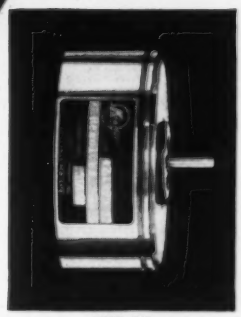
SIZE 23 "PANCAKE" SYNCHROS are suitable for gimbal mounting and are accurate to 2.5 minutes of arc.

SIZE 11 SYNCHROS for 4 wire systems offer accuracy of 3.0 minutes of arc. Standard 3 wire Synchros available with 5, 7 and 10 minute maximum errors.

ACTUAL SIZE

SIZE 25
MAXIMUM ERROR
30 SECONDS FROM E. Z.

SIZE 11



SIZE 23

KEARFOTT COMPONENTS INCLUDE: Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Indicators and other Electrical and Mechanical Components.

KEARFOTT SYSTEMS INCLUDE: Directional Gyro Compass Systems, Three Gyro Stable Platform Systems and Inertial Navigational Systems.

Particulars on these and other Kearfott Components gladly sent on request.

Kearfott GPE
A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J. Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas. West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle **19** on inquiry card.

Continued from page 2200

New York Stock Exchange:

National Acme	80 1/2	41	42 3/4
National Cash Register	70 5/8	46 1/4	49 3/4
North American Aviation	39 1/4	20 1/8	26 3/4
Northrop Aircraft	28 1/8	15 3/4	22 5/8
Otis Elevator	49 1/2	38 3/4	44 1/8
Philco	18 3/8	11	14 3/4
Radio Corp. of America	40	27	28 7/8
Raytheon	23 3/4	16 3/8	21 1/8
Rheem Manufacturing	21 1/4	11 3/4	12 5/8
Robertshaw Fulton	36 1/2	22 1/8	23 3/4
Reliance Electric	50 7/8	32 1/4	33
Sangamo Electric	39 3/4	29 1/4	35
Sperry Rand	26 1/8	18	18 3/4
Square D	35 3/4	21	22 3/4
Standard Coil Products	9 3/8	5 3/4	6 1/4
Starrett (L.S.)	85 1/2	59	61
Stewart-Warner	41 5/8	29	31 1/8
Sylvania Electric	46 1/4	30 1/2	33 3/8
Tel Autograph	8 3/4	4 1/8	4 1/4
Texas Instruments	31 1/2	15 7/8	24 3/4
Thompson Products	89 3/4	46	52 1/4
Tung-Sol Electric	37 1/2	23 3/8	24 3/8
Underwood Corp.	33 3/4	15	15 5/8
Union Carbide & Carbon	124 1/2	90	93 7/8
Unit Shoe Machinery	45 7/8	32 1/4	32 7/8
Western Union	20 3/8	14 1/2	16 1/8
Westinghouse Air Brake	33 1/8	20	20 5/8
Westinghouse Electric	68 5/8	52 3/8	60
Worthington Corp.	68 1/2	46 1/4	47 1/4

Over-The-Counter

	Quotation As of November 15th Bid	Asked
Aerovox Corp.	3 3/4	4 1/8
Aircraft Radio Corp.	19 3/4	20 3/4
Argus Corp.	14 3/4	15 1/2
Eitel-McCullough Co.	21 1/2	23
Electronics Associates	30 1/2	33 1/2
Elox Corp. of Michigan "A"	6 3/4	8
Erie Resistor Corp.	7 1/8	8
G. M. Giannini	13	14 1/4
Liquidometer Corp.	4 1/2	5 1/4
W. L. Maxson	5 1/4	5 7/8
Penn Controls, Inc.	13 1/2	14 1/2
Speer Carbon, Inc.	24 1/2	26
Sprague Electric	24 1/2	26
Taylor Instrument	29	31 1/2
Telecomputing Corp.	2 3/8	2 3/4
Topp Industries	9 1/2	10 1/2
Varian Associates	14 1/2	15 1/4
Vitro Corp. of America	16 1/2	17 1/4

for **miniature** and **sub-miniature** parts soldering

IDEAL

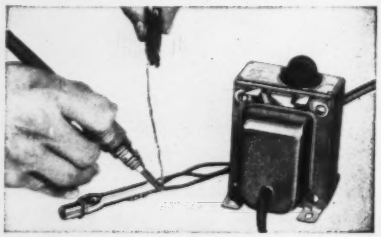
THERMO-TIP
RESISTANCE SOLDERING TOOL

Double Metal

Single Metal

Double Carbon

Single Carbon



Soldering large telephone jack with Thermo-Tip Resistance Soldering Tool and low voltage Ideal power unit.

Smaller, lightweight — for easy handling over prolonged periods of time. Thermo-Tip Tools are expressly designed as a production line tool. Reduces fatigue factor for women workers.

Pin-point accuracy. Pencil-small element fits into tight spots for foolproof soldering of small or miniature parts.

Fast, sure — Thermo-Tip elements concentrate high amperage current at soldering point for instant heat. Solder is melted by the parts to be joined—eliminates "cold flow joints", makes for positive union.

Versatile attachments—a variety of Thermo-Tip elements are available for every precision soldering purpose. Feed-thru electrodes on double metal, single metal and single carbon attachments provide longer life and easy length adjustment for specific job requirements.

Sold Through America's Leading Distributors. In Canada: Irving Smith, Ltd., Montreal

IDEAL **IDEAL INDUSTRIES, INC.**
1420-L Park Ave., Sycamore, Ill.

Gentlemen:

Kindly send us complete catalog information of Ideal's Thermo-Tip Resistance Soldering Tools.

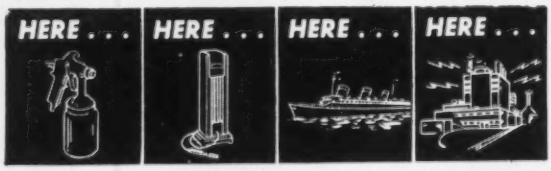
Name.....

Company.....

Address.....

City.....Zone....State.....

For more information circle **20** on inquiry card.

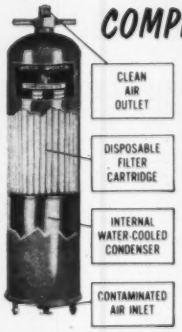


IN PLANTS THROUGHOUT THE WORLD ENGINEERS SPECIFY

HANKISON Condensifilters

for **INSTRUMENT-QUALITY COMPRESSED AIR**

HERE IS YOUR ANSWER TO COMPRESSED AIR PROBLEMS



From steel companies to steamships . . . from paint spray equipment to power plants . . . wherever POSITIVE PROTECTION for pneumatic instruments and controls is required, Hankison Condensifilters are specified.

Condensifilters eliminate:

- Moisture, *entrained and vaporized*
- Oil, *entrained and vaporized*
- Dirt — Scale — Rust

Write today for Bulletin M-7155R.

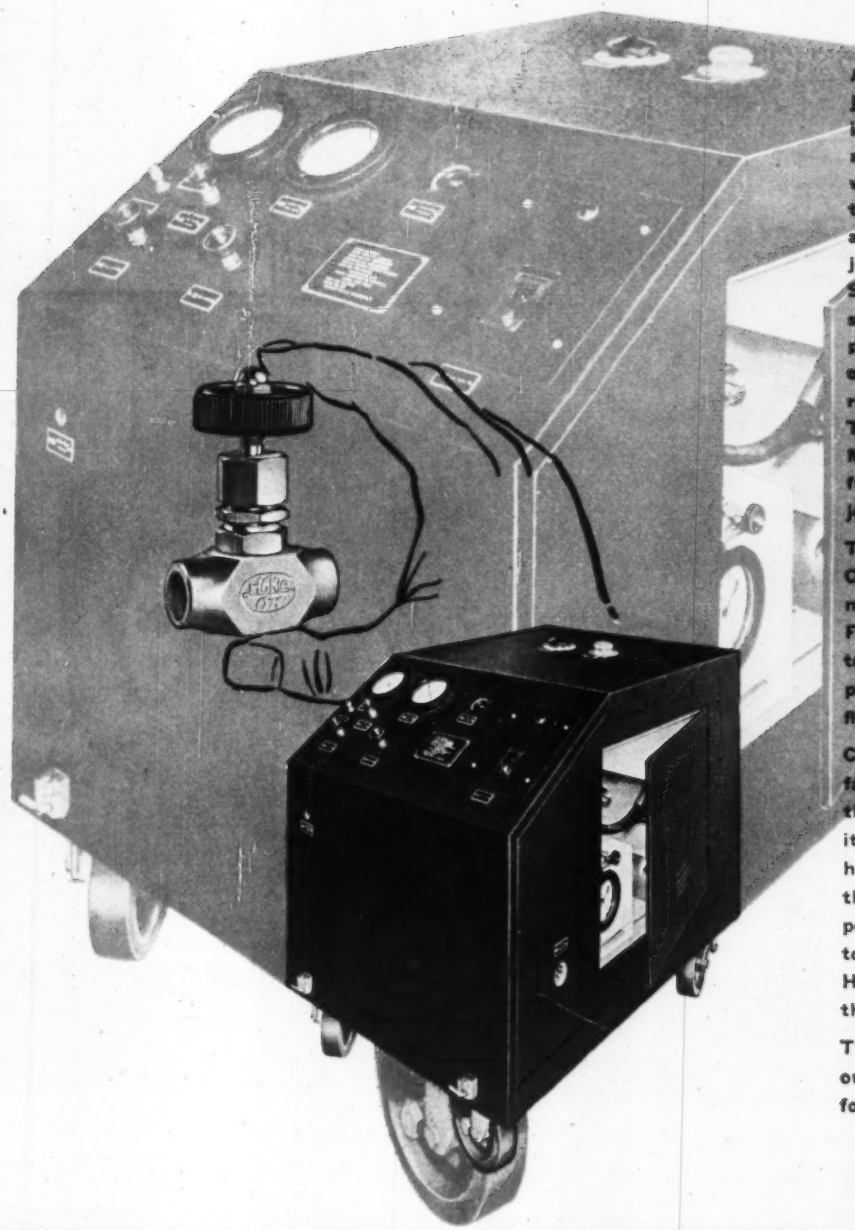
Condensifilters are ASME coded.

HC-12

HANKISON CORPORATION
College & Pike • Canonsburg, Pa.

For more information circle **21** on inquiry card.

small valves are judged by the company they keep



Anyone who has had experience with jet fuel will tell you how difficult it is to seal in. Like alcohol in your car radiator, it'll find a way out where water won't—and a favorite spot is the valve packing. Most valves shy away from "keeping company" with jet fuel . . . but not Hoke's 270 Series needle valve with O-ring stem seal. Flight Support Incorporated of Linden, N. J., uses five of them to handle the elusive material as it passes through their Model TE-7001 Portable Static Fluid Test Machine. The equipment checks fuel system components on turbo-jet engines.

Thanks to the resiliency of the O-ring and the accuracy of the machined bonnet into which it fits, Flight Support found the 270 Series to be best for their use . . . not a pound of pressure nor an ounce of fluid gets by!

Checking out jet engines is pretty fast company for small valves . . . that's why producers of high quality test and production equipment have often turned to Hoke for valves that measure up to such strict dependability requirements. Users, too, recognize the craftsmanship in Hoke's valves, and look for them on the equipment they buy.

There's more to the Hoke story in our new catalog (MV-957). It's yours for the asking.

HOKE, INCORPORATED, FLUID CONTROL SPECIALISTS, 231 S. DEAN ST., ENGLEWOOD, N. J.

HOKE

For more information circle **22** on inquiry card.

this is

This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test and in nuclear research.

*reproduced actual size, unretouched

The Model 906 Visicorder is years ahead of the trend. It is the first oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs lets you monitor high-speed variables as they go on the record.

a record of leadership

Some of the general features which give the Visicorder leadership in the direct-recording field are:

- Frequencies from DC to 2000 cps without peaked amplifiers or other compensation
- Six channels plus 2 timing traces on 6″ paper
- Deflection 6″ peak to peak; traces may overlap
- Record speeds 0.2, 1, 5, and 25 inches per second, minute, or hour
- Records require no liquids, powders, vapors, or other processing

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado.

MINNEAPOLIS
Honeywell

Heiland Division

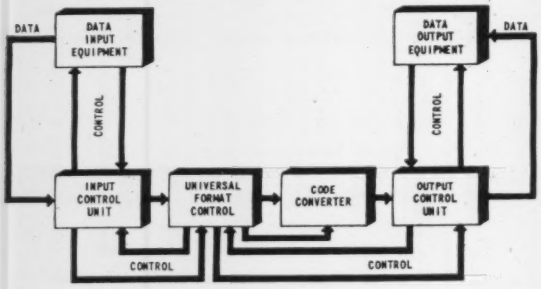
For more information circle **23** on inquiry card.

Briefs

For this literature circle number on inquiry card.

Computer Language Translator

Can ElectroData talk to IBM or Univac to Bizmac? . . . . The problem of rapid and efficient translation of computer data has been solved by the introduction of the Computer Language Translator. By means of this equipment, magnetic tapes recorded in the format of one com-

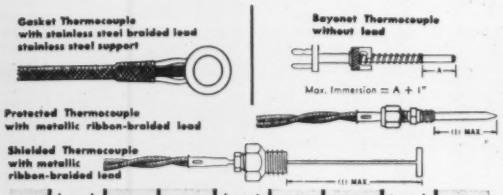


puter can be translated directly to magnetic tape usable by a different computer . . . . The basic block diagram of the Computer Language Translator is shown in Fig. 1. . . . . The Universal Format Control operates with any combination of input and output control units. The Format Control contains a 1092 character ferrite core memory which is used to store the input data as necessary during the translation process . . . . Several types of code conversion can be handled. (*From new* 4-*page Bulletin* 2A100 *Electronic Engineering Co., of Calif.*, 1601 *East Chestnut St., Santa Ana, Calif.*)

For this literature circle **201** on inquiry card.

Miniature Thermocouples

The *Gasket type* of thermocouple is ideally suited for many skin temperature measuring applications, such as those encountered in chemical and food processing, metal working, atomic energy, and other industries . . . *Bayonet thermocouples* are easy to remove because of the bayonet-lock cap—just twist and pull . . . *Protected thermocouples* are highly sensitive because the hot junction is welded or silver-soldered to the tip of the thin-walled protection tube. Outside tube diameters range from $\frac{1}{16}$" to $\frac{1}{4}$" . . . *Shielded Thermocouples* are used for accurately measuring temperatures of gases, and vapor mixtures of gases and


Gasket Thermocouple with stainless steel braided lead stainless steel support
Bayonet Thermocouple without lead
Max. Immersion = A + 1"
Protected Thermocouple with metallic ribbon-braided lead
Shielded Thermocouple with metallic ribbon-braided lead

°F	°C	°F	°C	°F	°C
−459.7	−273.2	− 0.4	− 18	194.0	90
−450	−267.8	+ 3.2	− 16	197.6	92
−440	−262.2	6.8	− 14	201.2	94
−430	−256.7	10.4	− 12	204.8	96

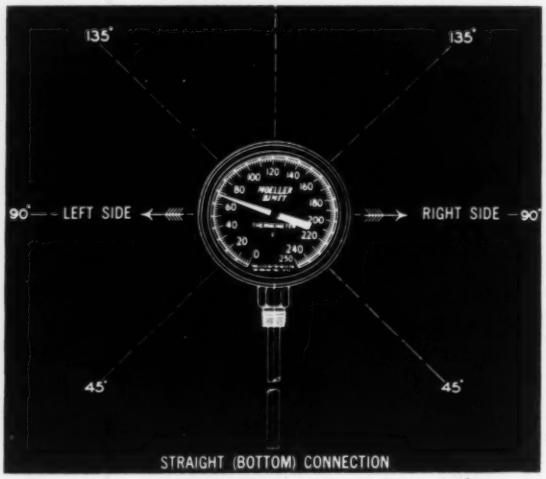
°C	°F	°C
− 27.8	194.0	90	32.2
− 26.7	197.6	92	33.3
− 25.6	201.2	94	34.4
− 24.4	204.8	96	35.6

liquids in such applications as gas turbines, pumps, and pipelines . . . (*From new* 28-*page Loose-leaf Binder, "Miniature Thermocouples," including Temperature-Conversion Table, Thermo Electric Co., Inc., Rochelle Park Office, Saddle Brook, N. J.*)

For this literature circle **202** on inquiry card.

Dial Thermometers

Moeller Maximum or Minimum Registering Bimet Dial Thermometers will indicate by means of a second pointer the highest or lowest temperature attained during any given time. The instrument is furnished with a red indi-

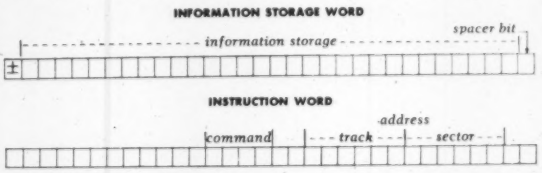


cator which is set so that it will move around the dial until it remains at either the highest or lowest temperature, thus indicating the maximum or minimum temperature that was attained as well as the current temperature . . . (*From new* 12-*page Catalog* 225-C, *Moeller Instrument Co., Richmond Hill* 18, *N. Y.*)

For this literature circle **203** on inquiry card.

LGP-30

The LGP-30 is a serial, single address, fixed point, binary, stored program digital computer . . . . The LGP-30 will operate on both alphabetical and numerical information. The computer is internally binary, which permits a desirable simplicity of design, yet imposes no restriction on the operator, who enters information in customary



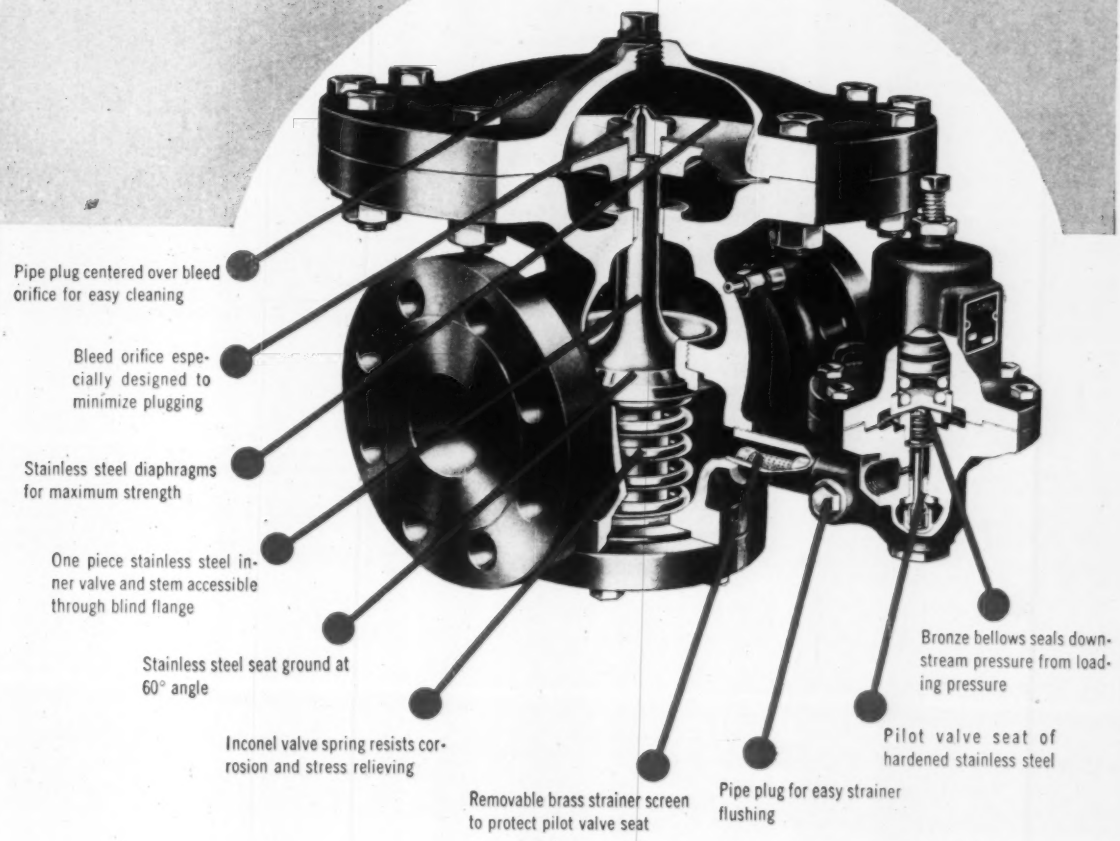
decimal form and receives the results in decimal form. Conversion is made by a standard input-output routine stored on the memory drum. The memory drum provides for 81 magnetic recording channels, each equipped with one or more read and record heads. Sixty-four of these channels comprise the main memory, used for storage of data to be operated on and for storage of instructions for the computer . . . . A channel in the main memory consists of 64 words, each containing 32 binary digits (bits). In the case of a word that is used only for storage of data to be operated on, one bit indicates the sign, 30 are used for information storage, and one is a spacer bit . . . . (*From new* 12-*page Bulletin RP2B-735, Royal McBee Corp., West Chester Ave., Port Chester, N. Y.*)

For this literature circle **204** on inquiry card.

THE FISHER® 92B

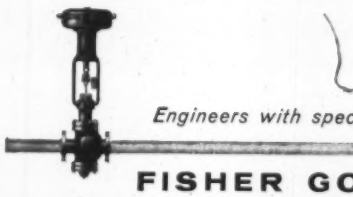
IMPROVED

TO MINIMIZE PROBLEMS INHERENT IN STEAM SERVICE


Pipe plug centered over bleed orifice for easy cleaning
Bleed orifice especially designed to minimize plugging
Stainless steel diaphragms for maximum strength
One piece stainless steel inner valve and stem accessible through blind flange
Stainless steel seat ground at 60° angle
Inconel valve spring resists corrosion and stress relieving
Removable brass strainer screen to protect pilot valve seat
Pipe plug for easy strainer flushing
Pilot valve seat of hardened stainless steel
Bronze bellows seals downstream pressure from loading pressure

Not content with the enviable performance record of the Type 92B, Fisher engineers have improved this pilot operated pressure reducing valve to a new peak of performance.

For extremely accurate, long trouble-free service, put a Fisher 92B in the line. One pilot with three interchangeable springs provides a range of from 2 to 150 psi. • *Send for Bulletin D-92 today.*



Engineers with special problems . . . find the ***answer*** *in . . .*

FISHER GOVERNOR COMPANY

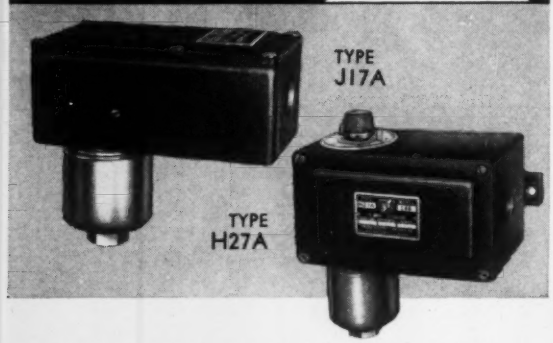
Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

For more information circle **24** on inquiry card.

Dual Switch PRESSURE-VACUUM CONTROLS

J17A | H27A



UNITED ELECTRIC's Types J17A and H27A Pressure-Vacuum Controls are similar units that have been designed for applications where it is desirable to control two separate circuits at different pressures by means of a single control unit. The major difference between the J17A and H27A is that the J17A contains an uncalibrated adjustment while the H27A has a calibrated dial and single turn adjustment knob and pointer for making pressure settings.

Adjustable Range	Various ranges between 30" Hg vac and 180 psi limits. H27A is calibrated.
Switch Differential	Factory pre-set for values of 1" Hg to 1 psi, dependent upon model.
Differential Between Switches	Factory pre-set for values of 3" Hg to 4 psi, dependent upon model.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Maximum Pressure . . .	Up to 180 psi.
Electrical Connections . .	Lead wires attached to internally located terminal blocks via a $\frac{7}{8}$" opening.
Pressure Connections . .	Via a $\frac{1}{4}$" female NPT on the bellows housing.
Enclosure	Die cast aluminum with a black wrinkle finish and a brass bellows housing.
Mounting	J17A — Via pressure connection. H27A — Via pressure connection or holes in two dog ears.

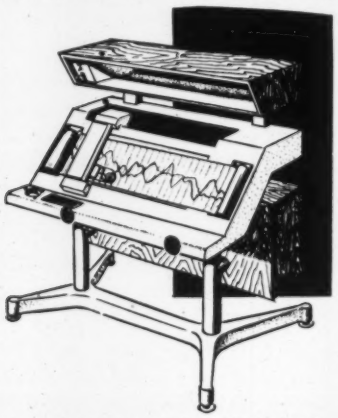
UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For special applications, standard units may be modified, or custom-built units can be provided. For additional data on standard pressure-vacuum controls, including Types J17A and H27A, request* Section 300 *of our* new *catalog.*

United Electric Controls
COMPANY
85 SCHOOL STREET, WATERTOWN, MASS

For more information circle **25** on inquiry card.

Data Reducer

The Type 099 DataReducer . . . . handles almost any type of record: film or paper, opaque or transparent, sprocketed or unsprocketed, continuous or framed, with orthogonal, curvilinear, or polar coordinates. It produces punched cards, paper tape, printed lists and/or graphic plots (either points or continuous traces) . . . . The record is stretched flat across the screen between magnetic

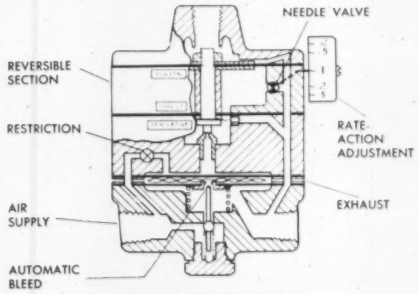


clamps. Rolls are held in troughs at each side. The target is carried by an arm . . . . Its movement up and down this arm is controlled by one handwheel. Movement of the arm back and forth along the record is controlled by another. If you want to read one trace at a time, and to apply a non-linear correction *automatically*, and read with a target instead of resorting to templates, we have a plug-in accessory called the linearizer. (*From new* 23-*page Loose-leaf Binder, "Telecomputing," Telecomputing Data Reduction Systems,* 12838 *Saticoy St., North Hollywood, Calif.*)

For this literature circle **205** on inquiry card.

Derivative Units

Direct Rate Action produces a correction which leads the process change and is, therefore, anticipatory. It is generally used on temperature and other processes having long time-lags . . . *Inverse Rate Action* . . . is beneficial on



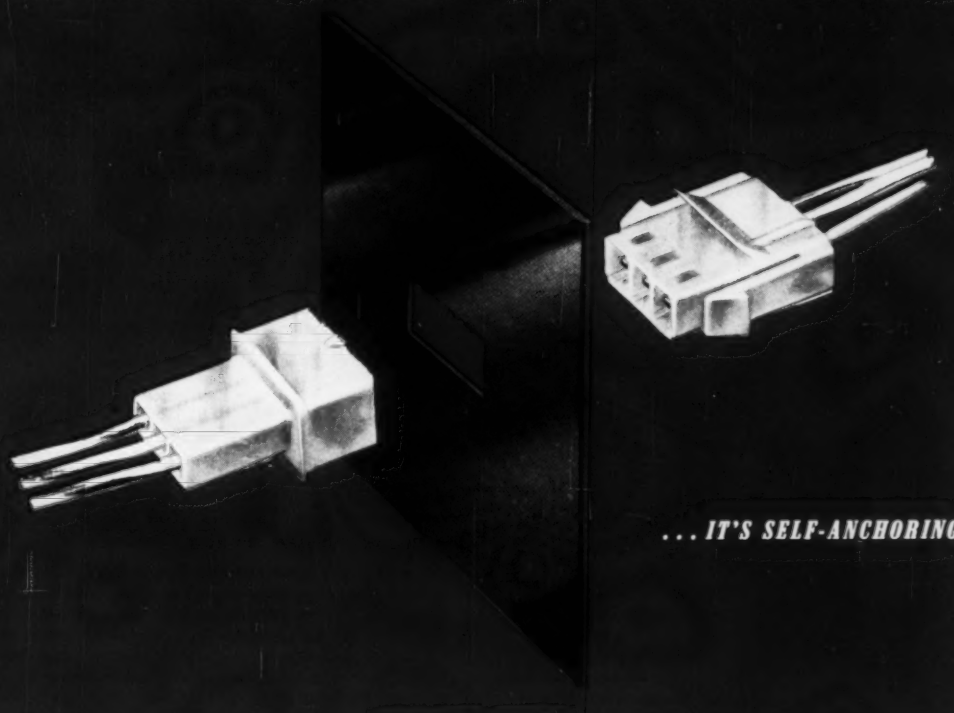
SCHEMATIC DIAGRAM
DIRECT DERIVATIVE

all processes with short time-lags—including liquid and gas flow, pressure, and liquid-level-control systems with small capacities . . . With inverse derivative, stability is maintained with the controller proportional-band setting reduced (often to one-fifth of normal) and the reset speed increased (sometimes to double the normal) . . . Nullmatic Derivative Units have a reversible section, so that either direct or inverse action can be produced. (*From new* 20-*page bulletin "Nullmatic Controllers and M/P Controls Stations," Moore Products Co.,* 901 *E. Lycoming St., Phila.* 24, *Pa.*

For this literature circle **206** on inquiry card.

AMP-lok

the new concept in multiple connector design



. . . IT'S SELF-ANCHORING

AMP

AMP-lok eliminates the necessity for supplementary mounting devices in through panel multiple connector applications.

Additional literature and samples available on request.

AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self-cleaning recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation – one simple mounting hole required
- color-coding available

AMP-lok can be used as a safe, free-hanging multiple connector, also.

AMP INCORPORATED

GENERAL OFFICES:

3739 Eisenhower Blvd., Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada • Aircraft-Marine Products (Great Britain) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP – Holland N. V. 's-Hertogenbosch, Holland
Distributor in Japan: Oriental Terminal Products Co., Ltd., Tokyo, Japan

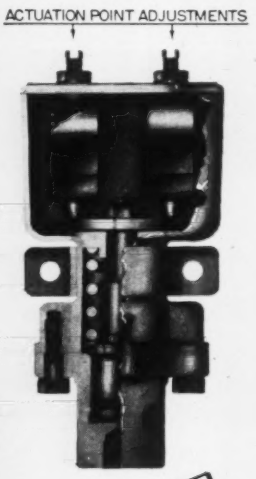
For more information circle **26** on inquiry card.

NEW PISTON PRESSURE SWITCH

— REALLY TWO FOR THE PRICE OF ONE

Model C9622 is capable of sensing two different pressures in one system and actuating independent electrical circuits at any two desired points, usually a job for two units. Useful where a system pressure must not exceed nor fall below predetermined values.

Simplifies plumbing, cuts installation cost in half, relieves space problems.



*With calibrated dials (both settings can be made visually without gauges) Without dials $29.50
Both prices subject to the usual quantity and trade discounts.

WE BUILD IN	WE DON'T USE
RUGGEDNESS Can take surges— (High proof pressures) Continuous operation— (Millions of cycles) No sticking— (in dirty fluid)	**LINKAGES & BEARINGS** Which wear quickly —(cause settings to drift and switch to fail).
LABOR & MATERIAL SAVINGS No return drain piping— (Sealed piston) Mounts where convenient (Operates in any position, Not sensitive to vibration)	**UNSEALED PISTONS** Which add to your installation cost (return piping). Are critical to dirt— (pistons get stuck).

BARKSDALE VALVES

PRESSURE SWITCH DIVISION
5125 Alcoa Avenue, Los Angeles 58, California
Ask for bulletins 9622 and C9622.

For more information circle **27** on inquiry card.

BRIEFS—CONTINUED

Pressure Sensitive Tapes

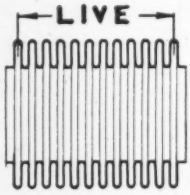
Basically, the Chart-Pak Method consists of pre-printed commonly recognized lines, bars, shapes, and symbols used in preparing graphs, charts, and layouts. They are printed on adhesive-backed, pressure sensitive tapes or sheets.

Symbols and shapes are professionally drawn and precision printed. You stick down what you want where you want it . . . (*From new 24-page 1957-Catalog, Chart-Pak, Leeds, Mass.*)

For this literature circle **207** on inquiry card.

Metallic Bellows

The action of a commercial bellows when compressed longitudinally from its free length to a position in which the convolutions touch each other is similar to the action of a spring under compression, except where for special

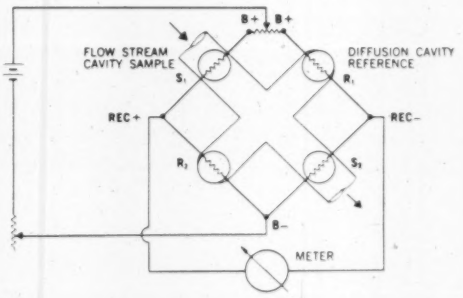


purposes, the bellows may have had to be treated after manufacture to remove cold working and spring action . . . In selection of a proper bellows for any application, many factors must be considered . . . Type of metal and its qualities, stress limits of the metal, internal and external pressures, and the total required movement . . . (*From new 8-page Bulletin No. 121 which includes vapor-pressure chart for filling media, Bishop & Babcock Mfg. Co., 4901 Hamilton Ave., Cleveland 14, Ohio.*)

For this literature circle **208** on inquiry card.

Anemometer Cell

The Gow-Mac Anemometer cell is a simple device for the measurement of very low flow, 50 ml/min or less, of gases. Two filaments are directly in the sample stream and are



cooled by mass heat transfer. The other two filaments are in diffusion cavities (heat loss only by conduction thru the same gas) thus serving as reference arms of a Wheatstone bridge, Current required—200 ma DC @ 1.5V. Zero balance is checked on static sample; variations in gas quality or pressure have no effect . . . (*From new 2-page Bulletin AC, Gow-Mac Instr. Co., 100 Kings Rd., Madison, N. J.*)

For this literature circle **209** on inquiry card.

CEC's NEW
PROCESS MOISTURE MONITOR

Response in seconds rather than hours, remote indication and control, and an exclusive design of the electrolysis cell guarantees top performance from CEC's 26-310 Process Moisture Monitor. Measurements are accurate down to one part per million. With a step-function change in sample concentration, the 26-310 will give approximately 63% response in 30 seconds, 95% response in one minute. The 26-310 is equipped with an accurate flow regulator and thermostatic temperature control. A five-step attenuator gives precise readings over the full-scale ranges of 10 to 1000 parts per million.

The all-weather Analyzer is explosion-proof for Class I, Group D, Division 1 hazardous locations. The Control unit is designed for control-room installation with a standard recorder. Contact your nearby CEC field office, or write for Bulletin CEC 1845-X5.

APPLICATIONS

Monitoring moisture content of instrument air streams.

Recording moisture level of feed stream to a low-temperature distillation unit.

Measuring water-vapor content of feed stream to a polymerization unit.

Monitoring water content in natural-gas transmission lines.

Monitoring dehydrating towers in gasoline plants for automatic regeneration.

Measuring water-vapor content of stored petroleum gas.

Monitoring the effectiveness of air-dryers in a process plant.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

Offices in principal cities throughout the world.

For more information circle **28** on inquiry card.

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 7

Covering design, development and application data on Emery Weighing Systems for industrial applications

ENGINEERS AT PARKE, DAVIS & CO. ADOPT NEW CONCEPT OF TANK WEIGHING IN BROMINE PROCESSING PLANT

SPECIAL CONDITIONS IN BROMINE STORAGE AND WEIGHING AREA PROMPTED SELECTION OF EMERY LOAD CELLS.

In selecting weighing apparatus for a bromine storage and process system at its Holland, Michigan, plant, Parke, Davis & Company engineers were faced with an interesting set of factors which led to the eventual choice of a relatively new concept in process control . . . tank weighing instead of measuring tank contents. Emery Hydraulic Load Cells were selected to handle the weighing job.

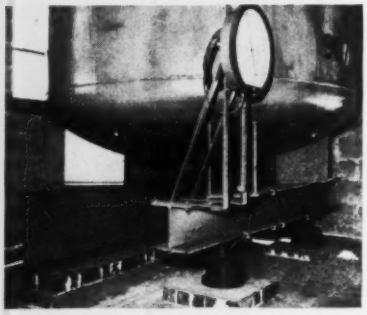


Fig. 1. Close-up view of the bromine storage tank showing how Emery Load Cells support the front end while the back end is carried on a 21" I-Beam.

The process required weighing of bromine in both storage and in process. Liquid bromine is pumped from the storage tank to an elevated intermediate tank where the required amount for use in the process is weighed. Excess bromine in the weigh tank is drained back to the storage tank. The system is vented through a fume scrubber.

The corrosiveness of bromine liquid and vapor dictated that an external gauging system be used. The lead lining of the storage tank precluded the use of gauging systems using radioactive sources. Compressed air of the necessary pressure was not available for weighing equipment using air as a motive force. The possible damage to beam scales by the corrosive action of chemicals and fumes was a deterrant to the use of this equipment. Equipment utilizing an electrical signal would have to be explosion-proof or remotely located from the hazardous area. Thus, Emery Hydraulic Load Cells were selected.

Two EC-30 Emery Cells support the storage tank in front; the back end being carried on a 21" I-Beam. The Emery 16" Indicator is set directly in front of the tank.

The weigh tank is suspended on a sling and linked to an overhead support through another EC-30 Emery Load Cell. A 21" dial indicator is located at floor level at which point the pump control is operated to fill the weigh tank with the required amount of liquid bromine which is then forwarded to the point of processing.

In specifying Emery Load Cells in this bromine weighing application, Parke, Davis & Company found that the peculiar conditions surrounding this particular installation were easily met by an Emery tank weighing system.

Fig. 2. Emery Dial Indicator for weigh tank is conveniently located above pump control. Operator can fill weigh tank to exact weight, then shut pump off.

If you face conditions of a similar nature . . . or if you have a tank weighing problem of any kind, our engineers will gladly study it and make recommendations. Be sure to send for our Bulletins 561 and 571.

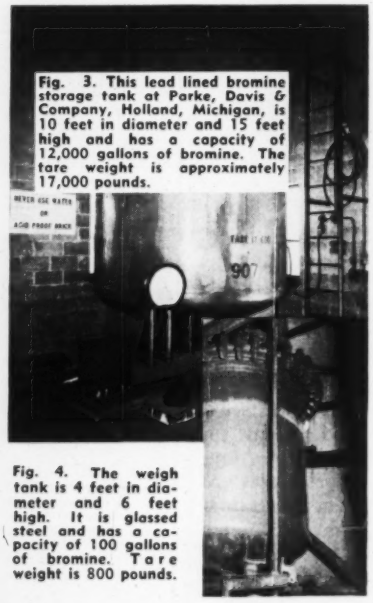


Fig. 3. This lead lined bromine storage tank at Parke, Davis & Company, Holland, Michigan, is 10 feet in diameter and 15 feet high and has a capacity of 12,000 gallons of bromine. The tare weight is approximately 17,000 pounds.

Fig. 4. The weigh tank is 4 feet in diameter and 6 feet high. It is glassed steel and has a capacity of 100 gallons of bromine. Tare weight is 800 pounds.

Tank Weighing Data

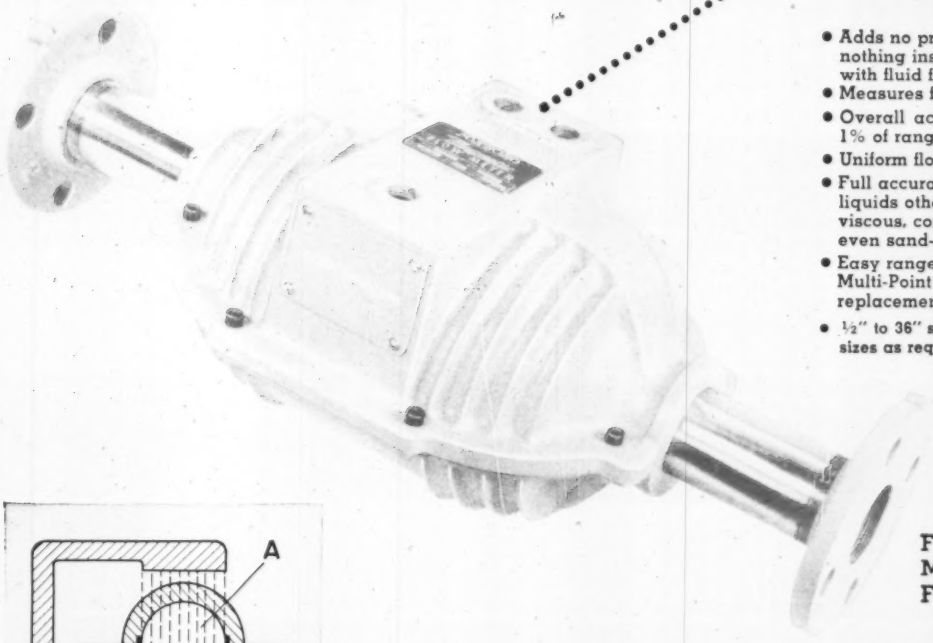
Our Bulletins 561 and 571 are filled with technical data on tank, bin and hopper weighing; the arrangement of cells and instrumentation; and the new approach to tank weighing through the results you need. If you have not received your copies send for them today.

THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.

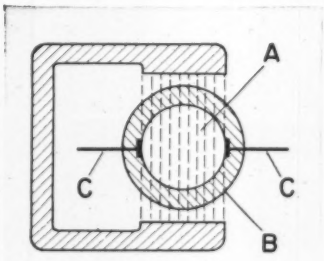
For more information circle **29** on inquiry card.

NOW! a flow meter with no flow restrictions!



- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- ½" to 36" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help your processing. Write for Bulletin 20-14A.

THE FOXBORO COMPANY, 4612 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO
REG U. S. PAT. OFF.

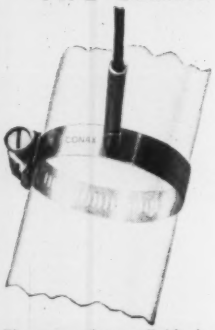
Foremost in FLOW METERING

For more information circle **30** on inquiry card.

Adjustable

conax®

PIPE CLAMP THERMOCOUPLE



for accurately reading outside pipe temperatures

advantages

- Used wherever immersion thermocouples are impractical or undesirable
- Used where extreme corrosion and erosion are problems
- Provides temperature readings on alloy, plastic or glass pipes that are not easily entered
- High pressure lines unbroken —a safety feature
- Installation and service without interrupting operations or flow
- Permits checking other temperature measuring devices
- Checks effectiveness of insulation
- Multiple units readily used for obtaining temperature gradients
- Installed in less than a minute

Thermocouples available in Copper-Constantan for low temperatures or Iron—Constantan and Chromel—Alumel up to 1000° F.

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

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2316 Walden Ave., Buffalo 25, N. Y.

For more information circle **31** on inquiry card.

SPECIAL PRICE . . .

ELEMENTARY ENGINEERING ELECTRONICS

With Special Reference to Measurement and Control

By ANDREW W. KRAMER

Managing Editor *Power Plant Engineering*, Member American Institute of Electrical Engineers, Associate Member Institute of Radio Engineers.

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While they last

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Acquire a better knowledge of electronics without trying to be a radio engineer.

Check, money order or cash must accompany order

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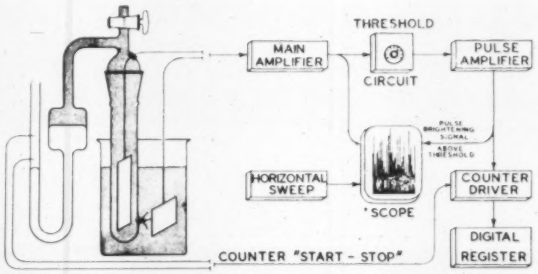
BRIEFS—CONTINUED

Particle Content Counter

Operation is based on electrical conductivity difference between particles and fluid suspension medium. Either can be the better conductor, and a suitable conductivity ratio may be obtained by adjusting fluid conductivity . . . As an individual particle is carried through the aperture,

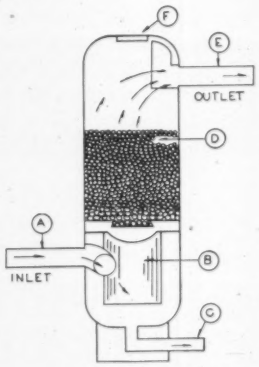


it displaces fluid medium within the aperture, changing the electrical resistance of the aperture contents. This produces a voltage pulse of short duration which has a magnitude proportional to particle size. Particle size ranges of 20 to 1 are handled; standard apertures cover the 2 to 70 micron range . . . (*From new 4-page Bulletin A-1, Coulter Industrial Sales Co., P.O. Box 22, Elmhurst, Ill.*)

For this literature circle **210** on inquiry card.

Moisture Control

The Van-Air Dryer offers a simple, economical and more efficient method of moisture control without regeneration. A specially formulated drying agent, "Dry-O-Lite," dehumidifies the compressed air, making it thoroughly "instrument clean, dry and safe." The dry air will

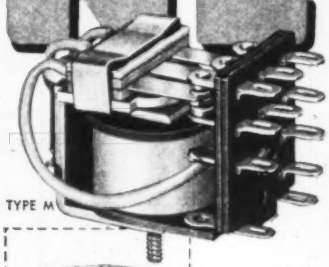


Automatic Drain Traps Are Recommended

have a dewpoint of zero °F or lower, depending on operating conditions . . . . Dry-O-Lite is a desiccant which slowly dissolves and is never removed or regenerated. About once a month the addition of a small quantity (far less than the initial charge) may be required . . . . Pressure drop is less than 1% provided the unit is not overloaded . . . . There are capacities up to 5400 scfm @ 100 p.s.i. and operating pressure up to 3000 p.s.i. . . . . (*From new 12-page Catalog D1-957NE10, Van Products Co., Erie, Pa.*)

For this literature circle **211** on inquiry card.

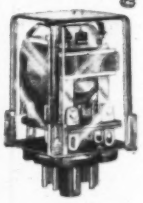
NEW



TYPE M

General Purpose Light Duty Relay

IDEAL FOR A WIDE RANGE OF APPLICATIONS



- For AC or DC operation.
- Compact size, lightweight.
- Shock, vibration resistant.
- Positive contact pressure.
- Contact combinations up to 3 "C".
- Cont. rating, 5 amp. resistive 5/32" dia. (10 amp. 3/16" dia.).
- Available with plastic dust covers, with plug-in feature.

Send for details

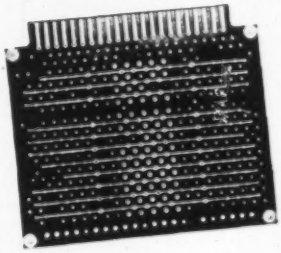
Comar ELECTRIC COMPANY
3349 ADDISON ST., CHICAGO 18, ILLINOIS

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

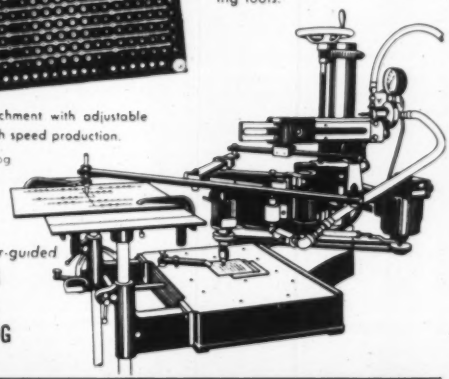
For more information circle **62** on inquiry card.

TRACER-GUIDED DRILLING
100 HOLES P. M.
WITH NEW HERMES Engravograph

for printed circuit plates



- Pantograph reproduces drill pattern from template in any reduction ratio — assuring high accuracy.
- Allows drilling and routing of different size holes in one operation without changing tools.



Pneumatic attachment with adjustable feed gives high speed production.

Ask for catalog XP-1

Also for tracer-guided
ENGRAVING
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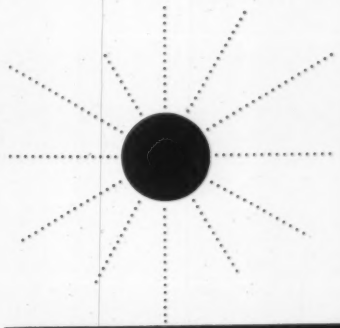
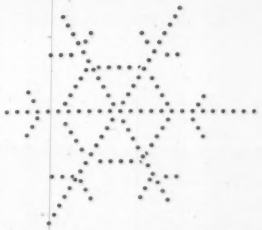
new hermes ENGRAVING MACHINE CORP
13-19 University Place, New York 3, N Y

For more information circle **63** on inquiry card.



HOT

–30° TO 1100° F. OR

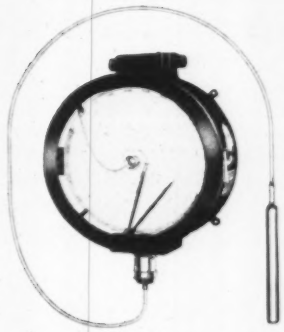


COLD

WITH PARTLOW
THE TEMPERATURE IS
PRECISION-CONTROLLED

partlow

THE PIONEER IN MERCURY THERMAL CONTROLS



Degrees mean dollars. That's why Partlow Controls are used in more and more applications where temperature control is critical. Their pin-point accuracy insures positive protection for materials and equipment. Partlow Controls are precision-built for use with gas, oil, steam or water valves; or electrical equipment. Available in 9 standard ranges, from –30° F. to 1100° F.

THE PARTLOW CORPORATION
Dept. IA-1257, 2 Campion Road, New Hartford, N. Y.

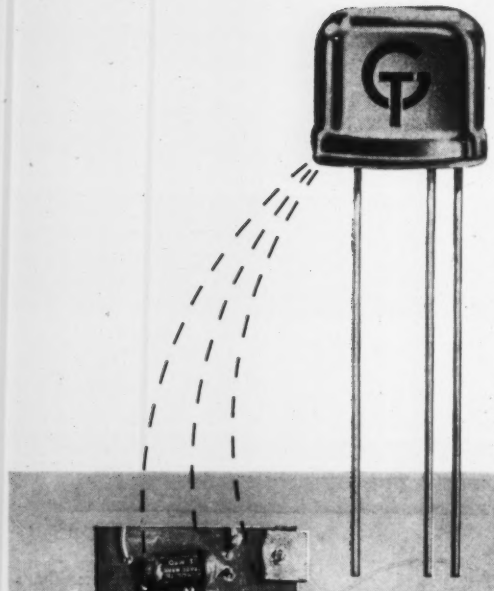
We'd like to know more about Partlow Temperature Controls.
☐ Have representative call. ☐ Send us your CONDENSED CATALOG.
We are interested in Partlow Controls for the following applications:

Company.....
Street and Number.....
City..... State.....
Signed.....

For more information circle **64** on inquiry card.

GENERAL TRANSISTOR

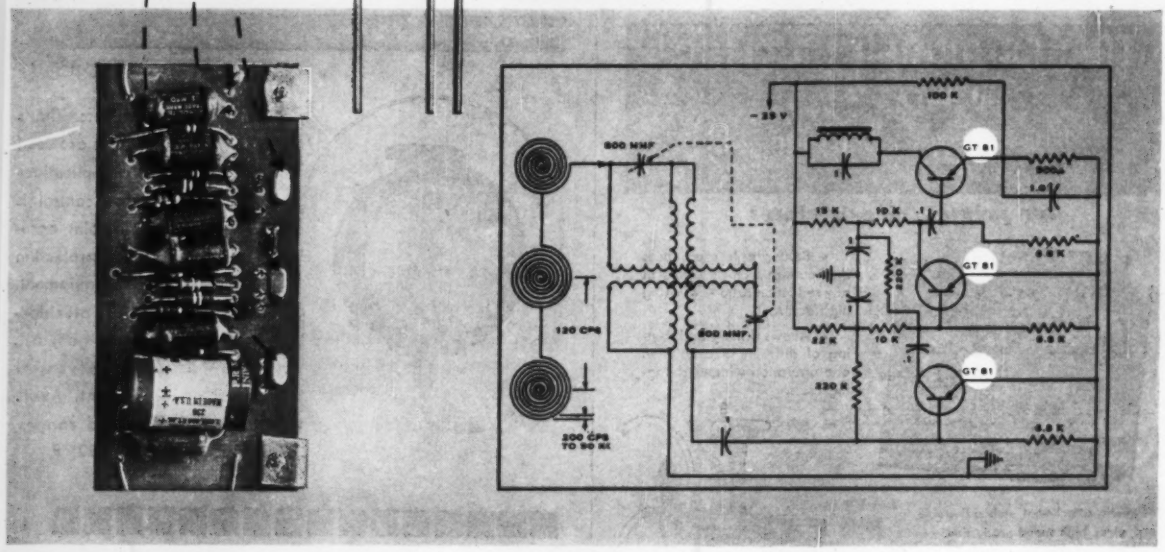
AIDS LOW-COST MINIATURIZATION OF WIEGAND MFG. CO.'S INTERCEPTOR TRANSFORMER



Damped oscillation output at twice the input frequency for use in telemetering and relaying . . . is the function of the Interceptor Transformer. This miniaturized system is compatible for carrier frequencies from 200 cps up into the megacycle range. Previous designs for this type of system using conventional components were bulky, and expensive.

Wiegand gave the problem of miniaturization to General Transistor. Following GT engineer's recommendation, a GT-81 transistor was used. This transistor met the specs . . . a response to signal amplitudes below 1 microvolt . . . it had to be highly reliable and able to withstand shock, vibration, and heat . . . ready availability for mass production in printed circuits . . . and finally, competitively priced.

Many of the leaders of industry turn to GT for the solution to their problems . . . strict quality controls, selected raw materials, environmental testing, engineering know-how, and modern production techniques assure a complete reliable product.



This is one more example why
General Transistor is the fastest growing name in transistors.
Send for Bulletin G-110.

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP 95-27 SUTPHIN BLDG. JAMAICA 35, NEW YORK
FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP, 91-27 138th PLACE JAMAICA 35, NEW YORK

GENERAL TRANSISTOR
CORPORATION
91-27 138TH PLACE JAMAICA 35, NEW YORK

In Canada: Desser E-E Ltd., 441 St. Francis Xavier, Montreal 1, Quebec

For more information circle **34** on inquiry card.

Two portables with

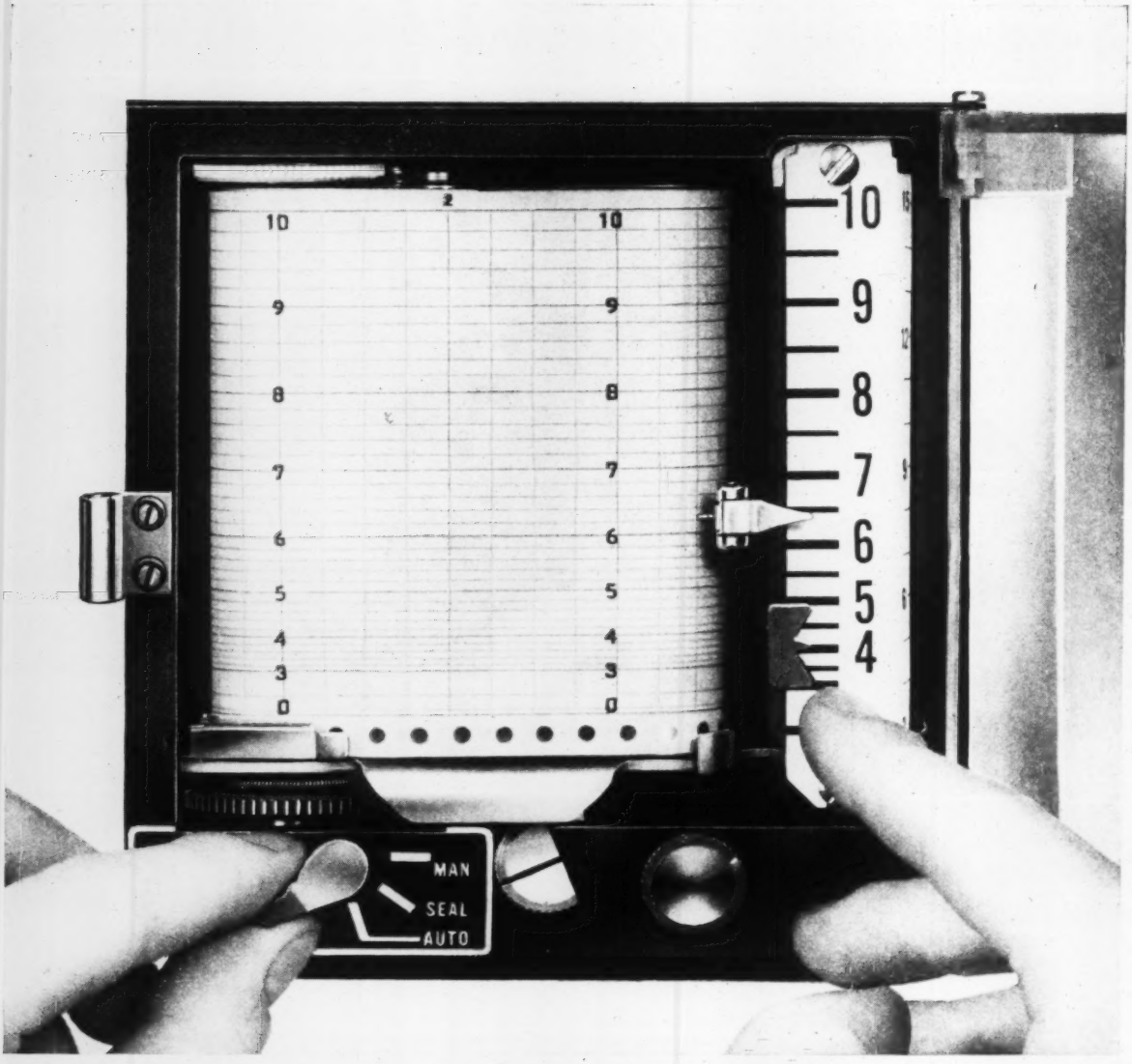
WIDE RANGE COVERAGE

Traditional Weston quality alone would keep these famous model 904 portable instruments *'way in the lead.* But their exceptionally broad range coverage, plus other exclusive features which distinguish this comprehensive instrument line such as . . . unequalled scale visibility . . . wrap-around windows . . . hand calibrated mirror scales and knife-edged pointers . . . convenient terminal locations . . . efficient shielding . . . rated accuracy of 0.5% . . . make them *standouts* for laboratory or shop portable needs. Other instruments in this broad line include D-C Voltmeters, Volt-Ammeters, Ammeters, Milliammeters; A-C Voltmeters, Ammeters, Milliammeters; and A-C and D-C single-phase Wattmeters. For complete information see your local Weston representative or write for literature . . . WESTON INSTRUMENTS, Division of DAYSTROM, Inc., 614 Frelinghuysen Avenue, Newark 12, New Jersey.

A DAYSTROM UNIT

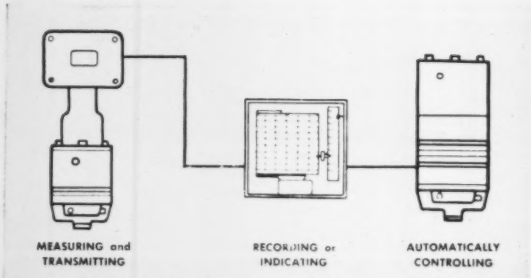
WESTON *Instruments*

For more information circle **35** on inquiry card.

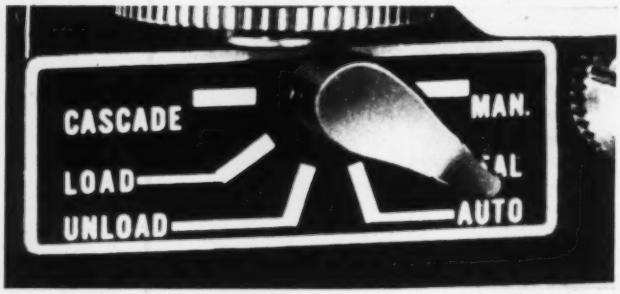


BRISTOL METAGRAPHIC RECEIVERS:

"Easiest 'bumpless



BRISTOL METAGRAPHIC INSTRUMENT SYSTEM



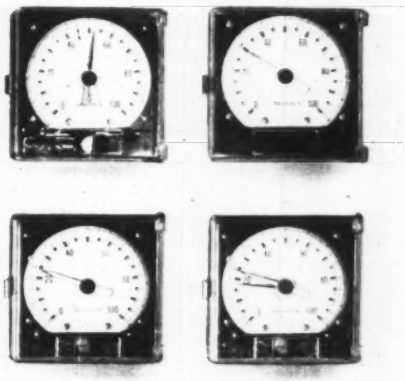
SIX-POSITION SINGLE-KNOB TRANSFER STATION (enlarged view) for cascade service. Three-position manual-automatic station is also available.

For more information circle **36** on inquiry card.

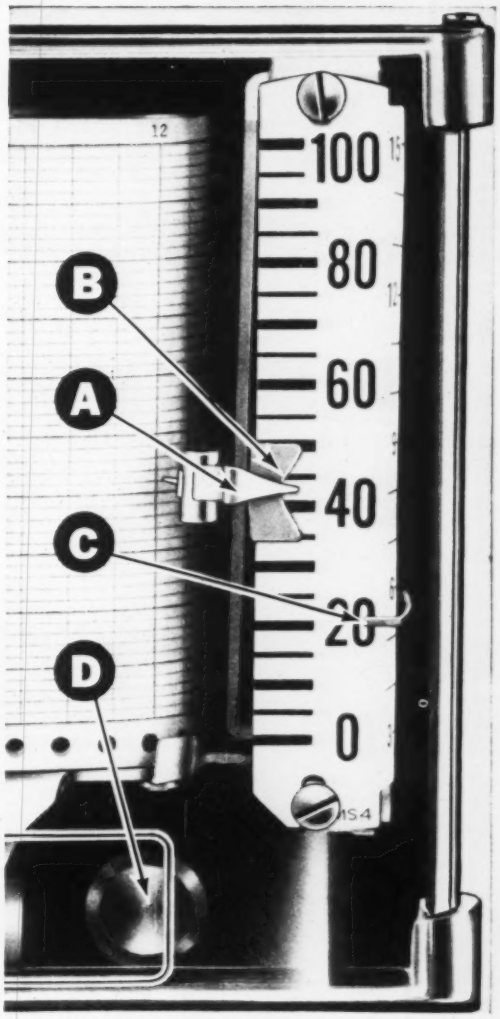
ONE OF 38 METAGRAPHIC RECEIVER MODELS you can choose from, all with 5" x 5⅛" panel, all fitting into same 4 9/16" square panel cut-out. This Metagraphic Recording Receiver has single-knob six-position transfer station, gives easy start up and initial adjustment and completely "bumpless transfer" in complex cascaded control systems. Single-knob, six-position transfer station lets you select:

1. Completely automatic-cascade operation.
2. Automatic operation of slave loop alone.
3. Manual operation.

You get "bumpless transfer" both ways between all three conditions. This convenient switching greatly facilitates start-up of cascaded systems and initial adjustment of slave controller proportional, reset, and derivative actions.



METAGRAPHIC INDICATING RECEIVERS have full 9-inch scale for easy reading; feature: Complete 10-second interchangeability with recorders, show valve position as well as set point and controlled variable. Highly visible fluorescent paint on pointers makes deviation of set point and variable instantly apparent from as far as 20 feet away.



METAGRAPHIC RECEIVER shows measured variable (A), set point (B), and valve position (C), all on same scale. That's what makes manual-automatic transfer so easy, bumpless, and error-free with this instrument . . . just seal, match pointers with knob (D), transfer—that's all there is to it.

transfer' you ever saw"

That's what instrument men say after trying the Bristol Metagraphic Pneumatic Receiver—even in complex cascade control systems.

Just seal, match pointers, transfer. There's not a single value to read. It's that easy because the Metagraphic receiver gives you one-knob control plus continuous valve position indication on the same scale with set point and measured variable.

A genuine plug-in receiver. The Metagraphic is a *true* plug-in receiver—no finger-disconnects. *It plugs and unplugs in 5 seconds with no loss of automatic control. The case acts as a blind controller while the receiver is out.*

Don't pay for pre-installation errors. The Metagraphic's full plug-in versatility lets you switch from indicator to recorder in less than 10 seconds, interchange many receiver models, change recorder range simply by changing chart. Cuts down on costly reinstallations if process requirements are changed.

Write for the complete story on Bristol Metagraphic Receivers. Bristol gives you the widest selection of plug-in miniatures on the market—pneumatic, telemetering, electronic. (Full-sized instruments, too.) The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 7.33

BRISTOL *TRAIL-BLAZERS IN PROCESS INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **36** on inquiry card.

DEPENDABLE
100% AUTOMATIC
REMOTE READING
Tank Contents Gauges

- RELIABLE
- NO POWER REQUIRED
- UNDERWRITERS' APPROVED

Liquidometers use a temperature compensated balanced hydraulic system. Indications unaffected by changes in specific gravity. All models feature large easy-to-read dials. UL approved switches available.

Write for complete details to Dept. E.

Since 1920 ...of proven quality

THE LIQUIDOMETER CORP.
LONG ISLAND CITY 1, NEW YORK

For more information circle **37** on inquiry card.

The Ametron Recording Counter

Counts faster, yet accurately.

Records in printed form.

Automatically resets.

Three important reasons why the Ametron Recording Counter is in demand by leading industrial plants and scientific laboratories.

Write for illustrated bulletin E

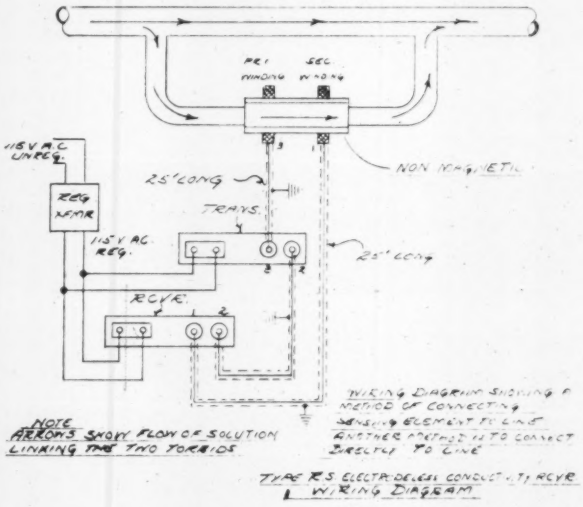
STREETER-AMET COMPANY
GRAYSLAKE, ILLINOIS
Branches in Detroit, Pittsburgh, Allentown, Birmingham and Los Angeles

THE STANDARD OF ACCURACY SINCE 1888

For more information circle **38** on inquiry card.

Indicating Conductivity System

The output of the transmitting unit is coupled to the primary toroid. The receiving unit reads the output voltage developed across the secondary toroid. When no solution is flowing, no coupling exists between the two toroids



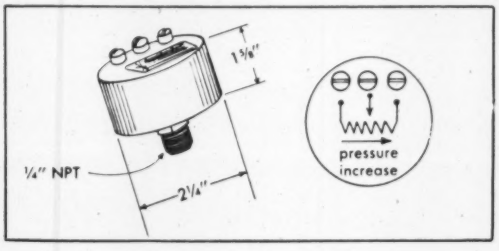
TYPE RS ELECTRODELESS CONDUCTIVITY RCVR
WIRING DIAGRAM

and no indication is obtained on the receiver unit. When solution is flowing through the system, coupling between the primary and secondary windings is obtained through a closed loop of solution. The return for this loop takes place through the metal housing of the toroid assembly. The coupling existing between the two toroids is a function of the conductivity of the fluid . . . (*From new 4-sheet Bulletins A-7502, A-7503, and A-7505, Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*)

For this literature circle **212** on inquiry card.

Pressure Transmitter

Output is in the form of precision resistance proportional to the input pressure. The signal may be of high enough level to be used in control, telemetering or remote recording circuits without amplification . . . The pressure



sensing element for the higher ranges is a specially designed Bourdon tube selected for superior linearity and hysteresis characteristics . . . The lower range pressure sensing element is a precision Ni-Span C capsule having excellent hysteresis characteristics . . . (*From new 2-page Leaflet S-051, Computer Components, Div. of International Resistance Co., 401 N. Broad St., Phila. 8, Pa.*)

For this literature circle **213** on inquiry card.

ANY ENGINEER who designs a product—or develops a process—requiring precise flow control or instrumentation will do well to consider the advantages of Wolverine small diameter tubing.

Wolverine produces two types:

The first, Wolverine Capilator®, is used for the precision metering of liquids, gases and air. It is plug drawn, actually formed over a tiny mandrel made from piano wire. Inside surfaces are mirror smooth with diameters held to the exact flow characteristics asked for by the customer. Capilator is particularly used for refrigeration and air conditioning. It is made in straight lengths only.

The second is Wolverine small diameter tubing for conventional instrumentation applications. It is a Tubemanship product—like Capilator—made in a wide variety of sizes in copper, in both straight and coiled form.

If you use small tube, better make Wolverine your "buy" word. Write today.

LOOK HOW SMALL!—Here is an actual photo of Wolverine Capilator next to an ordinary grease pencil.

BUY WOLVERINE TUBE—
IT'S MADE IN AMERICA

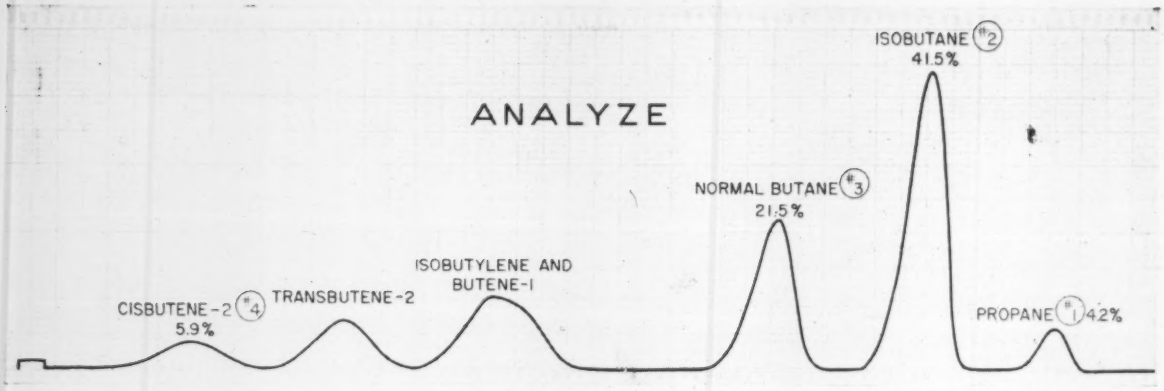
CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION

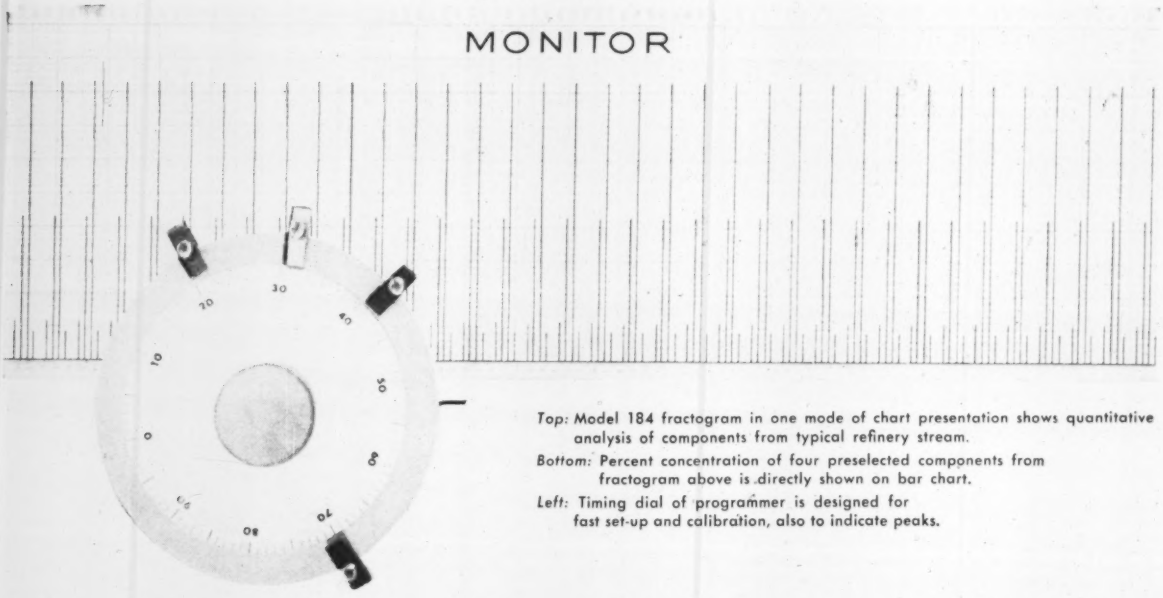
WOLVERINE TUBE
Division of Calumet & Hecla, Inc.
17260 SOUTHFIELD ROAD
ALLEN PARK, MICHIGAN
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

Plants in Detroit, Michigan, and Decatur, Alabama. Sales Offices in Principal Cities.

EXPORT DEPARTMENT, 11 EAST 48TH STREET, NEW YORK 16, NEW YORK

For more information circle **39** on inquiry card.





Top: Model 184 fractogram in one mode of chart presentation shows quantitative analysis of components from typical refinery stream.

Bottom: Percent concentration of four preselected components from fractogram above is directly shown on bar chart.

Left: Timing dial of programmer is designed for fast set-up and calibration, also to indicate peaks.

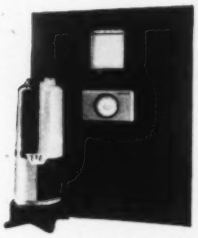
A New Instrument for

AUTOMATIC PLANT STREAM ANALYSIS BY GAS CHROMATOGRAPHY

After more than a year of field tests with ten leading oil and chemical companies, a new process vapor fractometer is now commercially available for multi-component analysis and monitoring of process streams.

The Model 184 is simple, versatile and reliable. Long term accuracy under plant conditions was a prime design consideration. Reproducibility is unequaled. Every safety feature has been incorporated.

Thanks to its in-plant evaluation by top instrumentation and process control engineers, the new P-E Model 840 can be put on stream with confidence—next year's afterthoughts are already built in.



Model 184 consists of analyzer unit in explosion-proof housing, panel mounted programming and recording units. Instrument monitors up to four components directly on bar chart.

INSTRUMENT DIVISION

Perkin-Elmer *Corporation*

NORWALK, CONNECTICUT

For more information circle **40** on inquiry card.

Circle **41** on inquiry card. ⟶

Look to Skinner in '58

for NEW answers to your control "puzzles"

Coming soon — several completely new solenoid valve lines loaded with such features as...

- **Lower prices**
- **Greater capacities** • **Higher pressures**
- **Long life expectancy—millions of cycles**
- **Diversified applications**
- **Wide selection of media handling**

And these are but a few of the many new advantages of Skinner's new solenoid valves. As always, of course, they'll be strictly manufactured to Skinner's highest-quality engineering standards.

Look for the announcements of Skinner's new valve lines in these pages throughout 1958. For advance information, write Dept. 11D.

Most important, these new valves will give you performance and applications that heretofore have not been possible!

SKINNER ELECTRIC VALVES

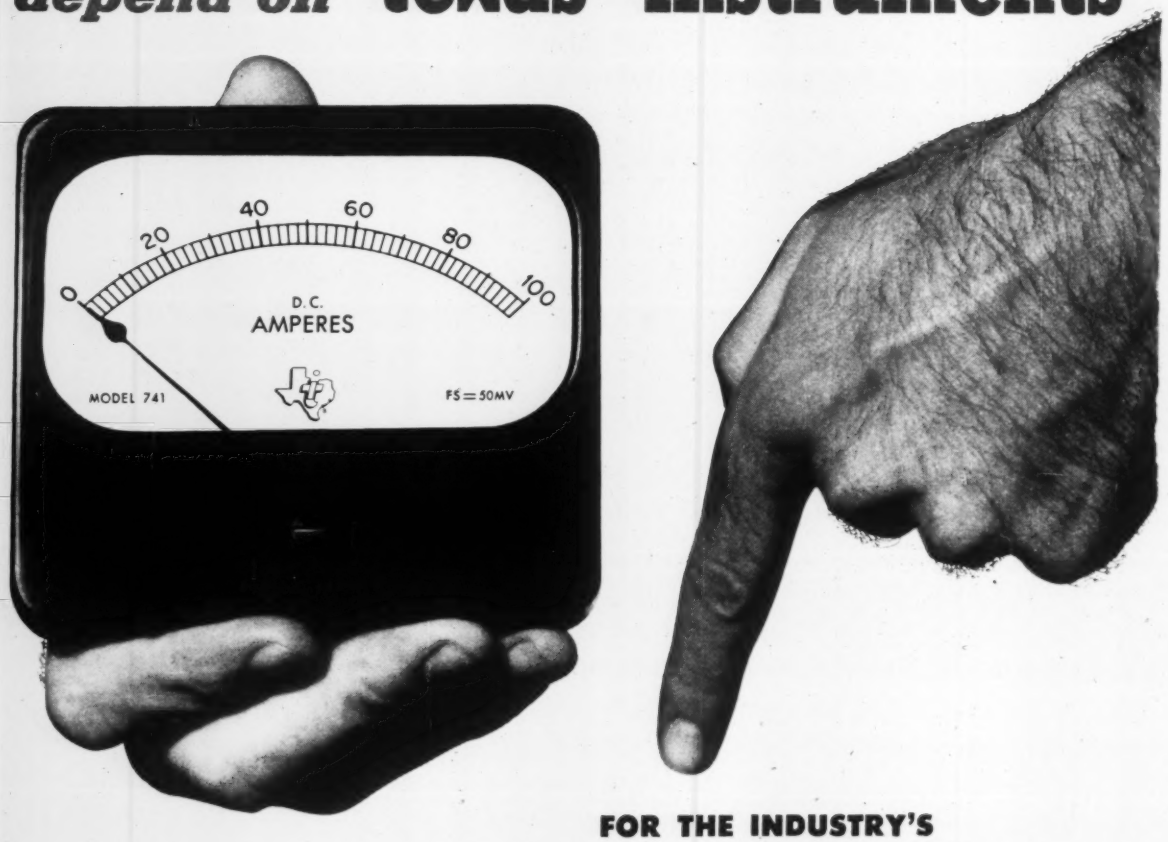
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE

for your panel instruments
depend on texas instruments



Get *immediate* prototype delivery of TI panel instruments . . . built to exceed MIL-M-6A or MIL-M-10304A with accuracies within 2% or less over full scale deflection and fill your panel instrument needs *now!*

FOR THE INDUSTRY'S

FASTEST DELIVERY!

movement — ac, dc, thermocouple, rectifier, elapsed time, vu, db

enclosure — molded phenolic case, hermetically sealed metal case, hermetically sealed ruggedized metal case

select from a wide choice

style — front-of-board, semi-flush, flush

size (inches) — 1½, 2½, 3, 3½, 4¼, 4½

shape — square, rectangular, round, fan

special — modification to your specifications

For rapid delivery of panel instruments . . . depend on Texas Instruments

WRITE FOR BULLETIN NO. DL-C 631

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 312 · DALLAS, TEXAS

For more information circle **42** on inquiry card.

Why **DYNALOG*** *design is out front of all electronic potentiometers . . .*

NO HIGH-SPEED MOVING PARTS!

Just stand near an operating Dynalog Electronic Instrument, and you'll quickly learn one reason why it gives longer sustained accuracy and maintenance-freedom than other balancing-type process control instruments!

There's none of the usual buzzing and clicking, because Dynalogs have no slidewire or fast-moving parts. Instead, a simple, variable radio-type capacitor with silent magnetic drive gives *stepless* continuous balancing — smoother, faster response — without noise, waste motion or wear.

In addition, this unique Dynalog Design is inherently free from "drift" . . . has no dry cells to standardize or replace . . . requires no lubrication or realignment . . . insures years of trouble-free performance without continual "policing". Dynalog Recorders and Controllers are used with any primary element . . . resistance, voltage, capacity, inductive. For the complete story, write for Bulletin 20-10. **The Foxboro Company, 4612 Norfolk Street Foxboro, Massachusetts, U.S.A.**

*Reg. U. S. Pat. Off.

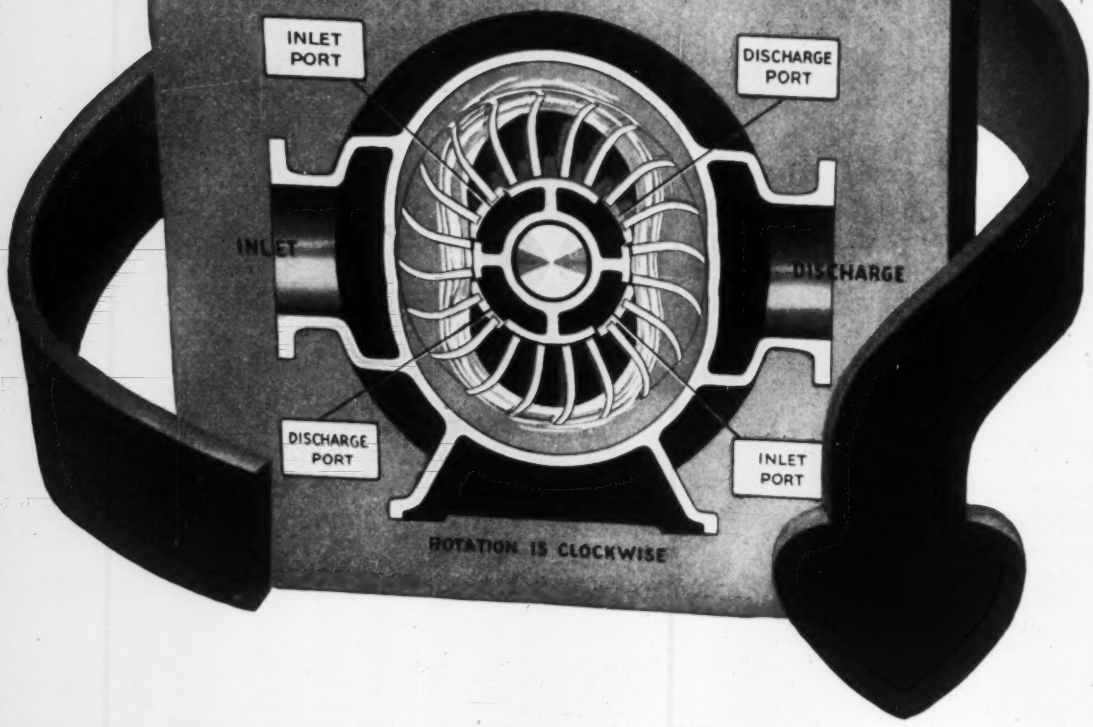
Advance features to improve control of temperature, pressure, flow . . .

1. No periodic maintenance
2. No dry cell—no standardizing
3. No high-speed moving parts
4. No slidewire or galvanometer
5. *Stepless*, continuous balancing
6. Adaptable to narrow spans

FOXBORO
REG. U.S. PAT. OFF.
DYNALOG
ELECTRONIC INSTRUMENTS

For more information circle **43** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

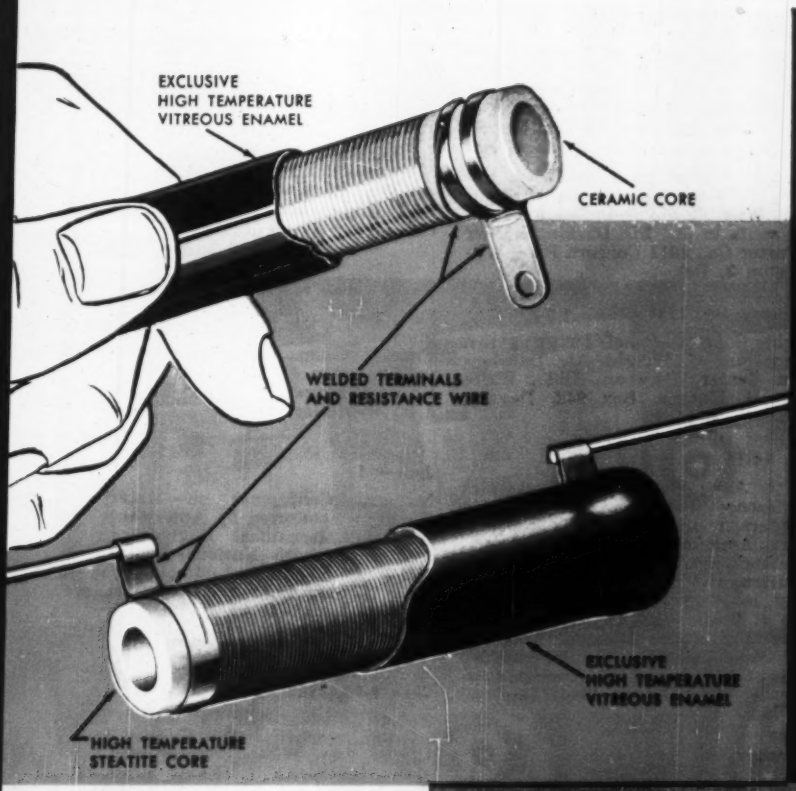
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

Circle 44 on inquiry card. ⟶

OHMITE®

WIRE-WOUND, VITREOUS-ENAMELED

POWER RESISTORS . . . *industry's most complete line*



WELDED RESISTANCE WIRE Ohmite Resistors have the resistance wire welded to the terminals instead of soldered or brazed. This provides a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

WELDED TERMINALS Another Ohmite Resistor feature is the welded terminal band. The band is permanently held together around ceramic core by means of welding, providing a strong, permanent fastening.

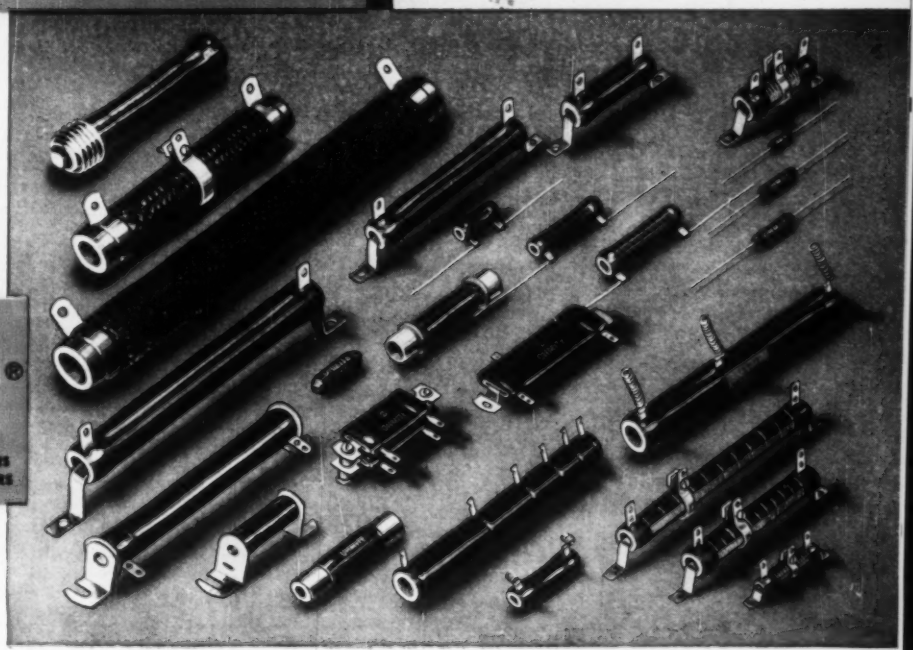
STRONG CERAMIC CORE This strong, rugged core has excellent electrical characteristics, and is unaffected by cold, heat fumes, or high humidity.

EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of core, terminal, and resistance wire.

Ohmite offers resistors in more than 60 sizes—ranging from 2½" diameter by 20" long to ¼" diameter by 9/16" long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK.

Ohmite offers the most complete line of wire-wound, vitreous-enameled POWER RESISTORS on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes, types of terminals . . . available in a wide range of wattages and resistances.

Write on company letterhead for Catalog No. 40.



BE RIGHT WITH

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

Ohmite Manufacturing Company
3615 Howard Street
Skokie, Illinois

NOW!
For Immediate Delivery!

Over $1,000,000 In ASCO Solenoid Valves Regularly Maintained In Stock

2-WAY
Normally Closed and Normally Open
Pipe Sizes: ⅛"—2"
Pressures: to 1500 P.S.I.
Voltages: 115-230-460/60
Solenoids: General Purpose, Watertight, Explosion Proof
Services: Air, Water, Oil, Gas, Steam

3-WAY
Normally Closed and Normally Open
Pipe Sizes: ⅛"—½"
Pressures: to 600 P.S.I.
Voltages: 115-230-460/60
Solenoids: General Purpose, Watertight, Explosion Proof
Services: Air, Water, Oil, Gas, Steam

4-WAY
Pipe Sizes: ¼"—1"
Pressures: to 300 P.S.I.
Voltages: 115-230-460/60
Solenoids: General Purpose and Explosion Proof
Services: Air, Water, Oil

HAND RESET
2-WAY
Pipe Sizes: ½"—1"
Pressures: to 250 P.S.I.
Voltages: 115/60
Solenoids: General Purpose
Services: Air, Water, Oil, Gas

3-WAY
Pipe Size: ⅜"
Pressures: to 250 P.S.I.
Voltages: 115/60
Solenoids: General Purpose and Explosion Proof
Services: Air, Water, Oil, Gas

STRAINERS AND FILTERS
Pipe Sizes: ⅛"—3"
Pressures: 250 P.S.I.; 450°F
Services: Air, Water, Oil, Gas, Steam

Special purpose solenoid valves and accessories are also stocked.

All sizes and types of ASCO Solenoid Valves now carried in stock by our warehouse in Los Angeles, and by stocking distributors in all principal cities.

Send for ASCO Solenoid Valve Stock List and Selection Guide.

ASCO

Automatic Switch Co.
82-F Hanover Road, Florham Park, New Jersey
FRontier 7-4600

For more information circle **45** on inquiry card.

Events

January 30, 31, 1958

Seventh Annual Instrument Short Course co-sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor Junior College, Wilmington, Calif. For information write Thomas H. Ponton, 640 Fillmore St., Fillmore, Calif.

Feb. 3-4

ISA Symposium on Chemical & Petroleum Instrumentation, Hotel Dupont, Wilmington, Del. For information write to Mr. Bill Durkin, Fischer & Porter Co., 2011 Concord Pike, Wilmington 3, Del.

February 3-4, 1958

Flight Control—Panel Integration symposium at Wright Air Development Center, Dayton, Ohio. Write John H. Kearns, Box 942, Dayton, Ohio.

Feb. 14-15

Fifth Annual Cleveland Electronics Conference sponsored by Cleveland chapters of Institute of Radio Engineers, American Institute of Electrical Engineers, Instrument Society of America and Cleveland Physics Society, in cooperation with Case Institute of Technology and Western Reserve University, Masonic Auditorium, Cleveland, Ohio. For information write to Cleveland Electronics Conference, 14700 Detroit Ave., Cleveland 7, Ohio.

February 18

14th Annual Quality Control Clinic of Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

March 11-13

Eighth Annual Conference on Instrumentation for the Iron and Steel Industry, sponsored by Pittsburgh Section, Instrument Society of America, Roosevelt Hotel, Pittsburgh. For information contact Fred D. Marton, 845 Ridge Ave., Pittsburgh 12, Pa.

March 26-28

20th Anniversary Meeting of American Power Conference, sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago. For information write Conference Director R. A. Buddenholzer, mechanical engineering dept., Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

April 22-24

Electronic Components Conference, Ambassador Hotel—Los Angeles, Calif. For information write David M. Knox, Packard-Bell Electronics Corp., 12333 West Olympic Blvd., Los Angeles 64, Calif.

May 4-7, 1958

The Fourth National Flight Test Instrumentation Symposium of the Instrument Society of America, Symposium Committee, Park Sheraton Hotel, New York City, N. Y. For information write P.O. Box #113, Bethpage, Long Island, New York.

May 7-17

United States World Trade Fair, New York Coliseum, N. Y. For information write to U. S. World Trade Fair, 331 Madison Ave., New York 17, N. Y.

May 12-14

Annual Symposium ("New Principles in Instrumental Methods of Analysis") of Instrument Society of America, Analysis Instrumentation Div., Shamrock Hilton Hotel, Houston, Texas. For information write ISA, c/o R. D. Eanes, Leeds & Northrup Co., Phila. 44, Pa.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.m., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 9-12

National Conference on Materials Handling sponsored by American Society of Mechanical Engineers (in conjunction with National Materials Handling Exposition), Public Auditorium, Cleveland. For information write to Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

June 9-13, 1958

Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

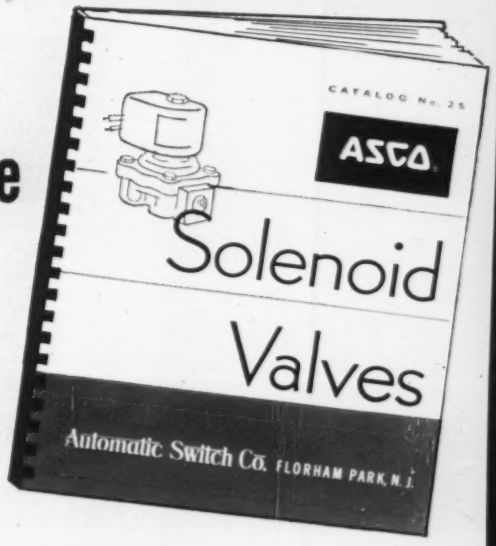
June 23-27

12th technical Photographic Exhibit in conjunction with 61st Annual Meeting and 13th Exhibit of Scientific and Testing Apparatus and Laboratory Supplies sponsored by The American Society for Testing Materials, Hotel Statler, Boston, Mass. For information contact E. W. Walsh, Chairman, ASTM Photographic Exhibit, The Narragansett Electric Co., 15 Westminster St., Providence, Rhode Island, *or* the Headquarters of the American Society for Testing Materials, 1916 Race St., Phila. 3, Pa.

August 5, 6 and 7

1958 Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers of The American Institute of Electrical Engineers (AIEE), Hotel Statler, Los Angeles, Calif. For information write to G. C. Anderson, Autonetics Dept. 388-64, 9150 E. Imperial Hwy., Downey, Calif.

ASCO makes Solenoid Valve selection simple

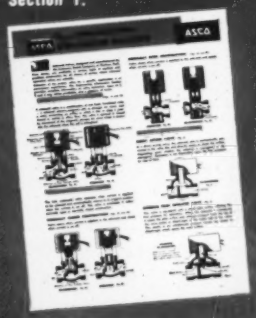


Comprehensive Design Engineering Data Now Available
Keys Proper Solenoid Valve to Application

Specifically designed to make the selection of solenoid valves simple, the ASCO Valve Catalog gives you the most comprehensive engineering data available to aid you in your solenoid valve selection.

Here are 114 pages of up-to-date valve information. These pages incorporate detailed engineering sections. Finding the proper valve for your particular application is made easy by a simple *master index* which leads you to a *separator* where you will find all the valves of the type you require. Each *separator* has a more detailed *index* which will enable you to turn right to the *valve bulletin* needed to meet your particular requirements.

Section 1.

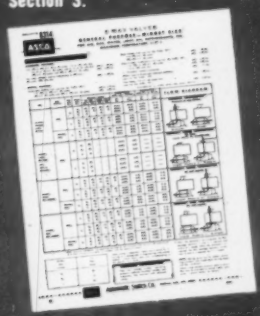


GENERAL ENGINEERING INFORMATION
Expanded engineering data with diagrams, gives valve construction, operating principles, features. With nomographs using Cv ratings for valve sizing.

Section 2.

2-WAY VALVES
Covers all 2-way valves of the fully automatic type for a wide range of pipe sizes and pressures.

Section 3.



3-WAY VALVES
Detailed information on fully automatic valves for pilot control of diaphragms or cylinders, or for diverting flow in pipelines.

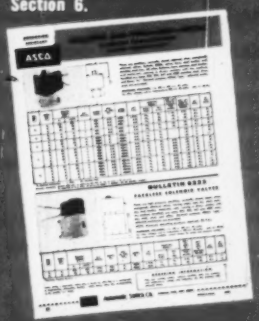
Section 4.

4-WAY VALVES
Fully automatic types covered. Both single and dual solenoid construction for general purpose and J. I. C. requirements.

Section 5.

MANUAL RESET VALVES
2 and 3-way solenoid valves for safety shut-off applications.

Section 6.



CORROSION RESISTANT VALVES
Includes 2 and 3-way solenoid valves for handling corrosive gases and liquids. Section incorporates a selection guide chart.

Section 7.

SPECIAL PURPOSE VALVES AND ACCESSORIES
Special purpose equipment: waterproof and explosion proof solenoids, laundry valves, cylinders, etc.

Section 8.

NUCLEAR VALVE DATA
Shows ASCO specialized solenoid valve designs for nuclear, guided missile, Navy and dispensing applications.

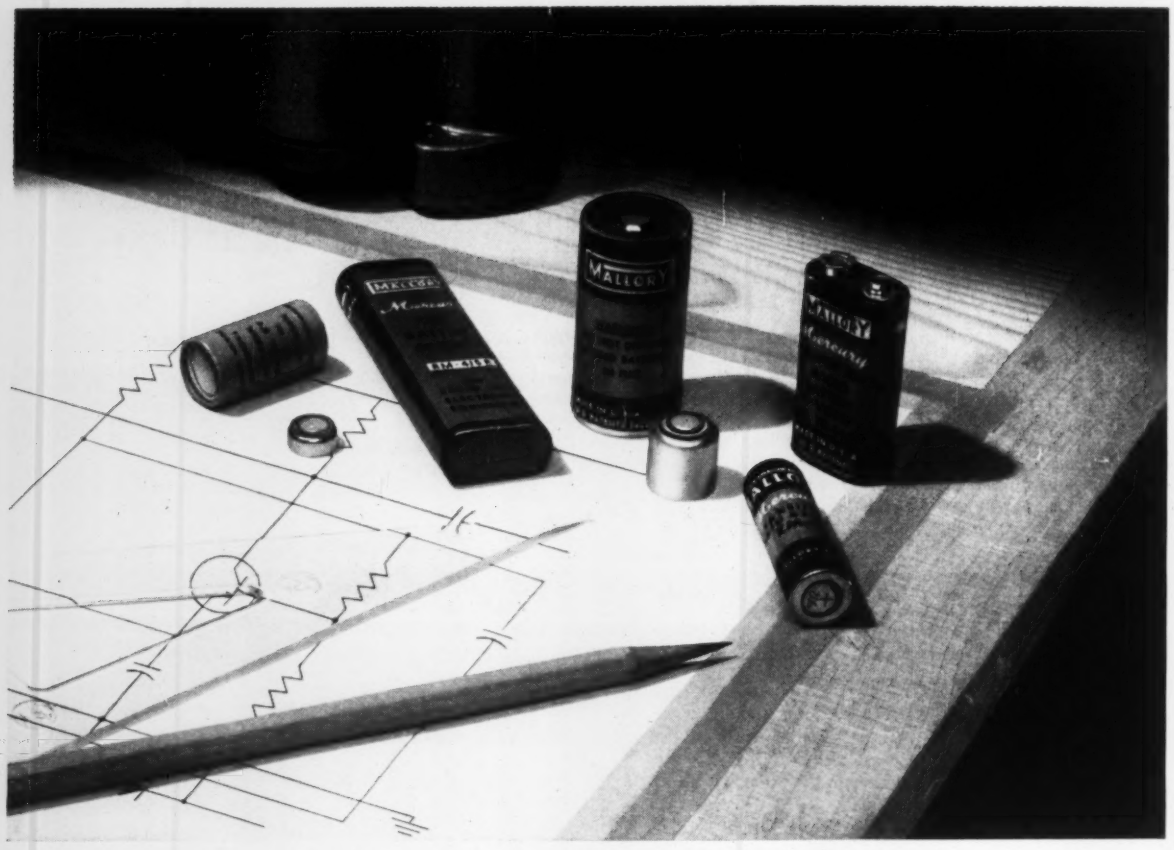
You may order the complete catalog or individual sections or bulletins. You will find easy to use return reply cards in each catalog for ordering additional literature. Also available is the Electromagnetic Control Master Catalog 57-S or any one of the six sectional Catalogs covering Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, Solenoids or Electric Plant Controls.

For more information circle **46** on inquiry card.

Any of these important engineering reference aids may be obtained by writing Automatic Switch Company – *on company letterhead only please.*

Automatic Switch Co.
52-F Hanover Rd., Florham Park, N. J.
FRontier 7-4600

ASCO



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Design for miniature size. Tiny Mallory Mercury Batteries put a lot of energy into minimum volume. The battery is no longer the limiting bulk component in your designs.

Design for user convenience. Mallory Mercury Batteries outlast ordinary batteries *several times*—both in service and in storage. Nuisance of frequent battery replacement is ended. Cost per hour is low.

Design for user satisfaction. This battery sets a new standard of performance. Its constant discharge provides fade-free operation, exactly matches transistor requirements. Its voltage is amply accurate for use as a reference in many instrument and bias circuits. Its rugged design withstands extremes of temperature and humidity.

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Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries

Metallurgical — Contacts • Special Metals • Welding Materials

For more information circle **47** on inquiry card.

Little Toot Gas Analyzer

Panhandle Pete

"INSTRUMENT manufacturing isn't what it used to be," remarks I to J. L. "Bus" Wallace, Chief Engineer of WESCO! One day recently. "A few years ago all we had to worry about was a dozen other instrument manufacturers—now we have competition from everything from aircraft companies, satellite launchers, and ditch diggers, to several thousand systems engineers—not to mention our own engineers who want to go into business every time they read the financial columns in the trade magazines."

"Speaking of engineers who want to go into business," replies Bus, "we better drive down to Long Bottom to visit the factory and check up on those rumors we've been hearing about a threatened revolt in the management of the Branch Factory. After all, we don't want the Otto-Fullbritch Company in competition with us, do we?"

As Bus and I drove up to the factory, our eyes were caught by a group of trailer-trucks parked along side the place. "My gosh, Bus, look! The gang is getting ready to move out on you." So we dashed into the office to check on this move—and there sat Waldo, feet on the desk, an open Handbook of Chemistry and Physics on his lap, tooting on a shiny tin whistle.

I have always thought Waldo to be but a short distance from insanity, and this looked like proof that he had at last slipped his trolley. But before I could tell Bus to get the man with the wagon, Waldo gives a loud series of toots on the whistle and says, "Cuz, meet the latest insterment in the world-famous line of WESCO! products—The Little Toot Gas Analyzer."

"Do you mean to tell me that you are sitting there tooting a whistle as part of a research project," I asks in amazement.

"Not only research (toot, toot) but also development." replies Waldo. "The Little Toot will be a companion model to our Aves analyzers, and we can make it in all popular sizes and prices, including the portable." (Toot, too.) "Also it is foolproof and fail-safe. (Toot toot.) Also, anybody can run it. (Toot toot.)"

"Waldo, just what is this new idea that looks like a whistle but acts like a gas analyzer," says I, knowing full well that genius and a million dollars often lies behind the simplest of ideas, thinking of the zipper, the safety pin, and the nuclear-magnetic-resonance transistorized-digitized combination push-button and process controller.

"Well Cuz, its like this. How many times have you gone out to work on a gas line and had to purge it out, huh, and used a messy old Orsat or some awkward 400 pound analyzer to know when the gas line was safe to fix, huh? (I've done this at least twice.—PP.) So it says in this here pretty red book about the sound made by a whistle (toot, toot) is dependent upon the spacific gravidy of the fluid used in the whistle and so, Cuz, all you have to do when you purge a gas line is screw our analyzer onto the gas line, using one of the handy adapters furnished in the kit for lines from $\frac{1}{4}$" to 60", listen to the sound of the whistle and then look up in the curves furnished free with the analyzer of frequency against gravidy of all the common gases and you've had it."

"Frequency may indeed by a usable technique for the variable," says I. "But what if the person using the Little Toot doesn't have absolute pitch. And also, how much can we charge for a little tin whistle?" I might as well find out how far Waldo has slipped.

"In that case, Cuz, we furnish a mike, a HI-FI amplifier, a precision sound generator, an acoustical impedance, and a frequency comparator."

"I must admit the idea begins to sound economic," I counters, "but suppose the guy is hard of hearing."

"At slight extra cost we furnish a high-class oscilloscope, a set of Lizzyjew figures, and a manual on how to match up the patterns. In fact, since you think all insterment men are deaf, dumb, and blind, we also furnish two of our 9006-B transducers with built-in model 300-J servo motors, the output of which is fed into an inverter-differintegrator-multiperplexor, from which we go to an electric typewriter, printing in Braille. And Cuz, we can furnish a recorder in cases where a customer wants one. All we do is run the output of the printer through our 456.8Z extraneous inertial data digital wave analyzer from which we get a minus 0.013 to plus 1.006 millivolt signal which can be applied to any commercial recorder."

"Hold on Waldo, where are you getting all the power to run this stuff and how do you expect anyone to lug it around. How about this portable model you mentioned?"

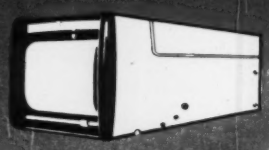
"Shucks Cuz, you got no imagination. WESCO! throws in a 100-KW DC diesel generator, a 200 KW inverter and a 300 KW rectifier to power the Little Toot Analyzer. For carrying the thing around, we can squeeze all this stuff into a trailer truck. At no extra cost, we'll arrange to have the side of the truck fold down to make a pavillion, where the operator of Little Toot can sit under the tent and concentrate on his work. As Shakespere said: 'A happy man is a good workman.' Best of all is the price: for only $999,568.38, including the whistle, we give the customer all this equipment plus a free roadmap. What more could anyone want, huh?" And Waldo slid down in his chair with a long 'Toot' on his whistle.

How ridiculous can we get? If anyone is interested in Little Toot, encircle the card for further details—and if you think this idea is ridiculous, wait till you see the inquiries we get.

Panhandle Pete

This pneumatic flow control gives

LIVE-ACTION RESPONSE . . . 1000 feet from panel!



Complete elimination of controller-to-valve response delay! True close-coupled control even when the operating panel is *hundreds* of feet away. These are big features you'll find in the Foxboro Model 59 flow control system.

The M/59 is the only controller specifically designed for direct mounting on the control valve motor. Need for brackets and controller-to-valve piping is eliminated. This unique force-balance controller has only two moving parts. There's no explosion hazard with this all-pneumatic system. And there are no bearings; no linkages – nothing to align or go wrong.

Learn how the fast response and simple adjustment of the low cost M/59 Controller, teamed up with the Foxboro d/p Cell Transmitter, will improve control of your process flows. Write today for Bulletin 470.

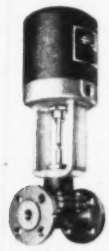
The Foxboro Company,
1412 Norfolk St.,
Foxboro, Mass., U.S.A.

MODEL 59
VALVE-MOUNTED
FLOW CONTROLLER

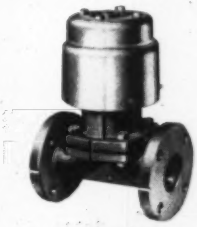
FOXBORO
REG. U.S. PAT. OFF.

FLUID FLOW SYSTEMS

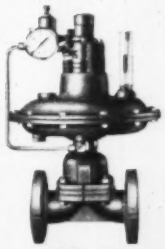
For more information circle **48** on inquiry card.



Barber-Coleman

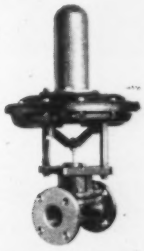


Bendix-Westinghouse Rotochamber

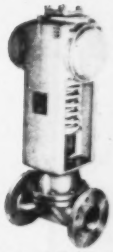


Conoflow

Fisher Governor

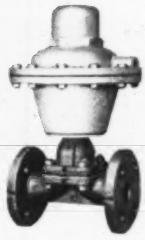


Foxboro Reversible Stabiflo



General Controls Hydramotor

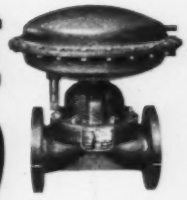
GRINNELL-SAUNDERS DIAPHRAGM VALVES with famous name POWER OPERATORS



Grinnell Air Motor, Spring Loaded

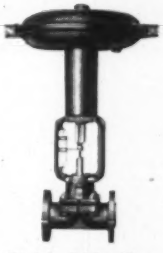
Grinnell Air Motor, Double-Acting

Grinnell Piston

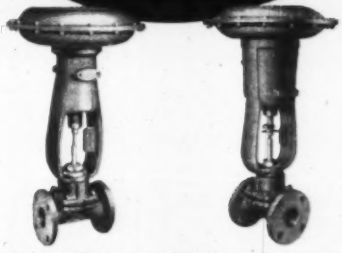


Hammel-Dahl Close-Coupled

Hammel-Dahl Preloaded



Kieley & Mueller



Mason-Neilan

Minneapolis-Honeywell

Philadelphia Gear Limitorque

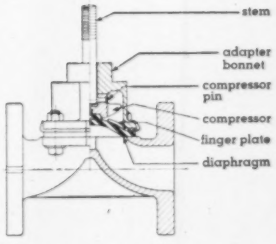
Taylor Motosteel

GRINNELL-SAUNDERS Diaphragm Valves are easily equipped for power operation — by combining any of numerous power operators, a sliding stem bonnet assembly, and a valve body. The sliding stem bonnet can be modified to accommodate any make of power operator, pneumatic or electric.

Grinnell-Saunders Diaphragm Valves are unsurpassed for handling materials as diversified as corrosive fluids, gases, beverages, foods . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

The operating principal of the Grinnell-Saunders Diaphragm Valve is simple. The resilient, flexible diaphragm is lifted high when the compressor is raised and pressed tight against the body weir when the compressor is lowered.

Grinnell valves are available with body, lining, and diaphragm materials to meet different service conditions. Write for further information.



This sliding stem bonnet is specially designed for power operation. The power operator is attached to the adapter bonnet and to the threaded end of its free-sliding stem. Thus, the operating force is applied *directly*. The stem, in turn, is directly connected to the compressor which opens and closes the valve when power is applied. This sliding stem bonnet is interchangeable with other bonnet designs.

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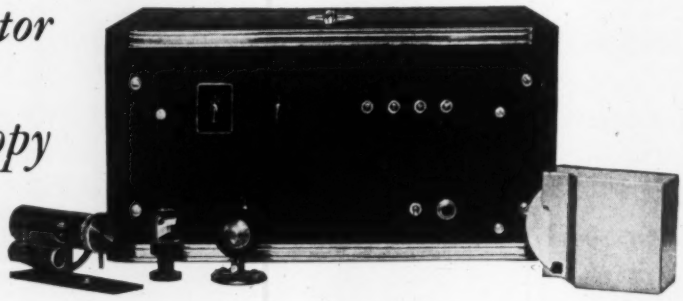
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic fire protection systems • Amco air conditioning systems

For more information circle **49** on inquiry card.

A Superior Detector

for

Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

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EQUIP FOR THE SIZE OF THE JOB

DRILL MICRO-HOLES

DOWN TO .0016" with SPEED & ACCURACY

ON *LEVIN*® INSTRUMENT LATHES

The Levin micro-drilling equipment shown here can be used with the smallest drills available. It is designed so that the drilling does not depend on the operator's sense of feel. The drill can be retracted for chip removal and returned to the drilling position without striking the bottom of the hole. While commercial drills can be had as small as .0016" this micro-drilling apparatus has successfully produced holes as small as .0006". **Send for catalog M describing complete line of instrument lathes and accessories. Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California.**

For more information circle **66** on inquiry card.

FIRST of the SIE *ADVANCED DESIGN INSTRUMENTS*

The M-3 SIGNAL GENERATOR

- 1 cps—120,000 cps
- Sine and Square Waves
- Less than 0.01% Drift per Hour after Warmup
- Less than 0.1% Distortion in Audio Range
- Frequency Calibration (1% + 0.1 cps)
- Calibrated Attenuator and Output Meter
- A necessity in a fully equipped electronics facility.

The new ADI instruments from SIE are based on an appreciation of the essential requirements for successful design and research instrumentation . . . Accuracy, Versatility, and Reliability. For example: the M-3 Signal Generator — first of the new ADI instruments — is designed to provide the research and design engineer with a highly accurate frequency source for applications ranging from amplifier design to telemetering measurements . . . and to meet these aims in a design which provides maximum "in use" convenience.

There will be new SIE instruments in the ADI Group available in the near future. Watch for their announcement, and, in the meantime, let your SIE representative demonstrate the M-3 in your lab. Check the accurate dial calibration and extremely low drift rate. You'll find a new standard of performance which really deserves the description . . . an Advanced Design Instrument. $495.00

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

Industrial Instrumentation for Industrial Progress

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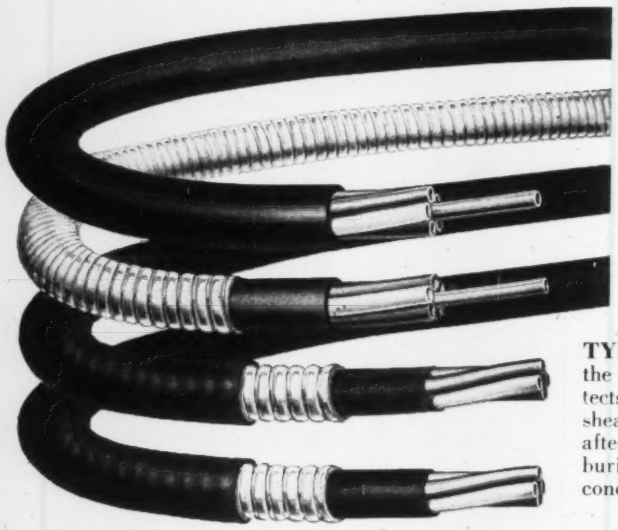
The Answer To Your Corrosion Problems

CRESCENT ARMORED MULTITUBE*

FOUR CORROSION-RESISTANT TYPES



TYPE CT—In damp or corrosive locations where a moderate degree of mechanical protection to the tubes is required, as in troughs or attached to sheltered building surfaces as supporting means, the first construction illustrated is recommended. It employs a tough, corrosion-resistant polyvinyl chloride thermoplastic sheath, resistant to water, acids, alkalies, oils and most chemicals, applied over CABLED copper tubes. The sheath will not support combustion.

TYPE CTA—gives corrosion protection to the tube, and the galvanized steel armor protects the tubes and polyvinyl thermoplastic sheath from mechanical injury during and after installation. Recommended for direct burial in concrete or pulling into underground conduits.

TYPE CAT—gives corrosion protection to the galvanized steel armor as well as the tubing. Recommended where the polyvinyl thermoplastic sheath will not be subject to mechanical injury.

TYPE CTAT—Combining the advantages of Types CTA and CAT, the fourth type illustrated has the polyvinyl chloride thermoplastic sheath both under the armor and over the armor, thus providing maximum mechanical and corrosion protection.

All these corrosion-resistant types can be furnished with copper, aluminum and polyethylene tubes, and up to 37 tubes.

Plastic Coated Single Tubes, copper or aluminum, should be used to give corrosion protection to all single lines up to the final tube fitting, where trouble from corrosion may occur.

Send for Bulletin 356-A giving complete information and engineering data

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON, NEW JERSEY

* Reg. Trade Mark

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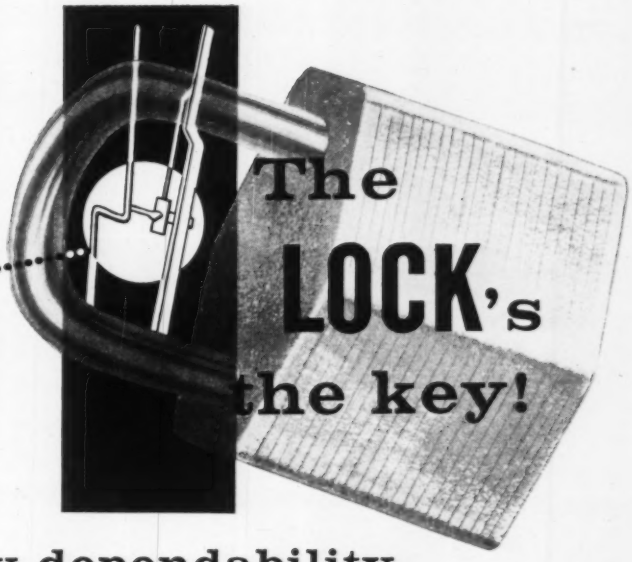

The LOCK's the key!

. . . to meter-relay dependability

The only truly dependable meter-relays are those built with locking contacts. For lasting, reliable contact action, meter-relay contacts *must* make firmly and break cleanly, every time.

An indicating meter with a couple of contacts stuck somewhere inside just won't do. Such an instrument may be excruciatingly accurate as an indicator, but it will fail miserably in a control application.

LET'S CLEAR THE AIR

We make these statements because there seems to be some misunderstanding about how contact meter-relays should be built and what they will do. Since they are the very heart of our business, we have the greatest concern for their reputation.

Indeed, we think everyone who has anything to do with meter-relays will benefit from a better understanding of them.

Trouble is, a meter movement alone won't do what it should

PRIMER STUFF, BUT PERTINENT

Any meter-relay which makes and breaks contacts by depending on the tiny forces inherent in a meter movement has been manufactured by whistlers-in-the-dark. Make and break must come from an auxiliary device. Without it, you'll get, at best, only a halting, exploratory type of contact. On the break, you'll get fluttering and arcing and probably sticking . . . at a point maybe 50% behind where the contact should have separated.

We use a locking coil to grab and hold the contacts. When they touch, there is no fooling . . . they close. The locking coil develops thousands of times as much press-together torque as the meter movement alone can generate. For positive separation, our meter-relays have a spring that loads when the contacts lock. When separation is desired, this spring unloads, flicking the contacts apart.

Operates 10,000,000 to 20,000,000 times

HERE'S HOW LOCKING PAYS OFF

Properly used, locking coil contacts will operate reliably 10 to 20 million times. Non-locking contacts will do well to make it through 100,000 cycles, and this at greatly reduced contact current.

It is true that the need to unlock contacts sometimes presents circuit problems. But think of the problems if a meter-relay's contacts won't work at all! Then you don't have a meter-relay—simply a mighty expensive indicator.

GET YOUR MONEY'S WORTH

Meter-relays are used to do hundreds of jobs because they are extremely sensitive, indicating and adjustable. If you've never tried them, we wish you would. If you've tried them and didn't make out so well, we'd like to have you try again.

In particular, try our locking coil types so you give meter-relays a fair shake—and do yourself a good turn in the bargain.

ASSEMBLY PRODUCTS, INC., 75 Wilson Mills Road, Chesterland 10, Ohio

Telephone: (Cleveland, O.) HAmilton 3-4436 • TWX: Gates Mills, Ohio 25-U

For more information circle **53** on inquiry card.

It's the **Original Equipment* idea . . . which simply means that, when you're figuring on electrical or mechanical counters in any new product, it pays to *design them in, when you begin.*

For then Veeder-Root quite likely can save you time and money by adapting or modifying a *standard* counter to your needs, instead of a special which you might specify on your own. This solves the counter problem . . . and saves you time in engineering, purchasing and assembly.

What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin . . .* it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

Series 1205
Reset Magnetic Counter

Everyone Can Count on Veeder-Root

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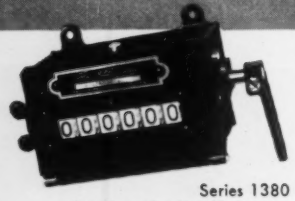
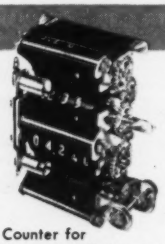
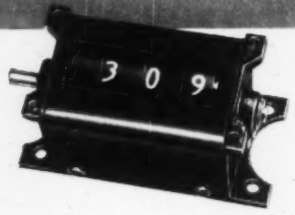


Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)



4-bank Counter for Radio Transmission Equipment



360-degree Bearing Counter

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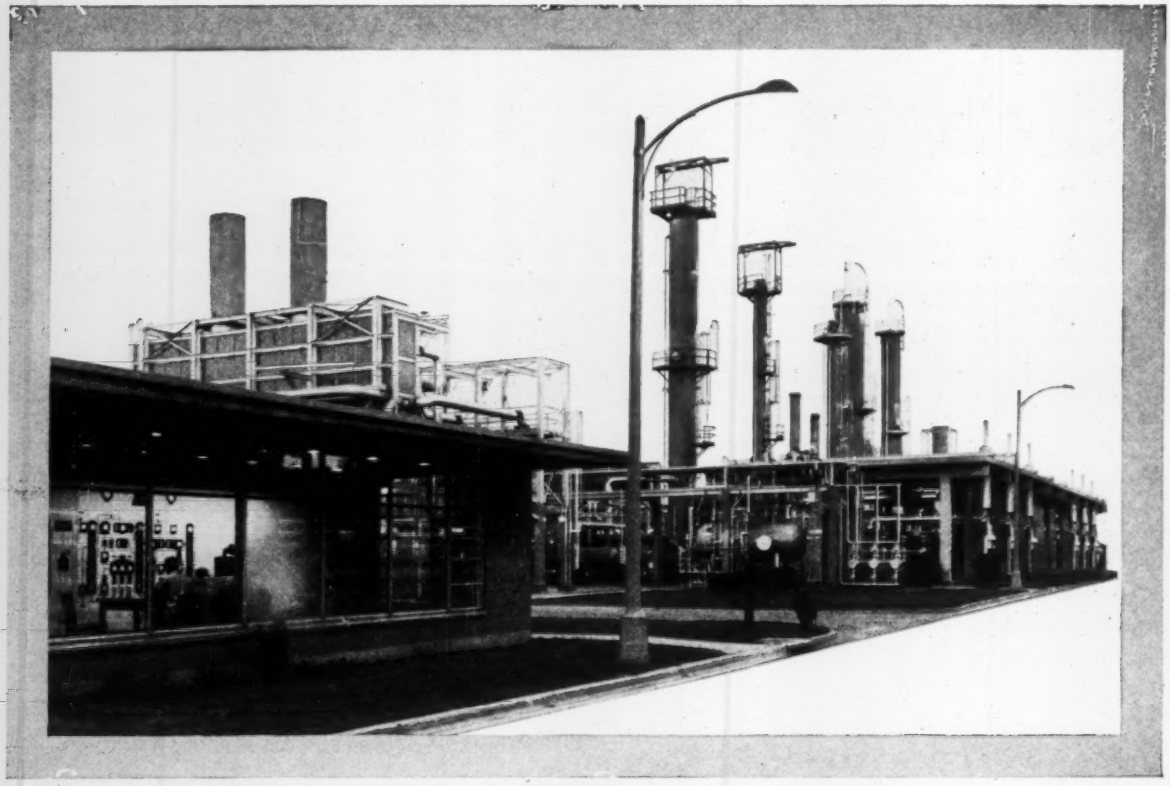


Electronic Control SAVES THOUSANDS OF DOLLARS even before start-up

Here is how: The installation of 'American-Microsen' Electronic Controls eliminated the need for a new control house when a new platformer unit was erected at the Pontiac Refining Corporation in Corpus Christi, Texas.

The existing control house (shown above) is far from the site of the new unit. Transmission distances up to 800 feet were involved—distances too great for conventional process instrumentation. But 'American-Microsen' Electronic Instruments are completely unaffected by distances up to 30 miles. Accurate dc signals are transmitted over simple 2-wire circuits with split-second speed. Consequently, Pontiac found it both practicable and economical to install the new platformer instrument panel right in the existing control house.

In addition, transistors, printed circuits and miniaturized components provide the ultimate in reliability, service life and space-saving simplicity. These are but a few of many reasons why 'American-Microsen' — the all-electronic system that uses only three units — is widely preferred for measurement, transmission and control. Write for literature and ask that a sales engineer from our nearby district office call and explain fully. No obligation, of course.

MANNING, MAXWELL & MOORE, INC.

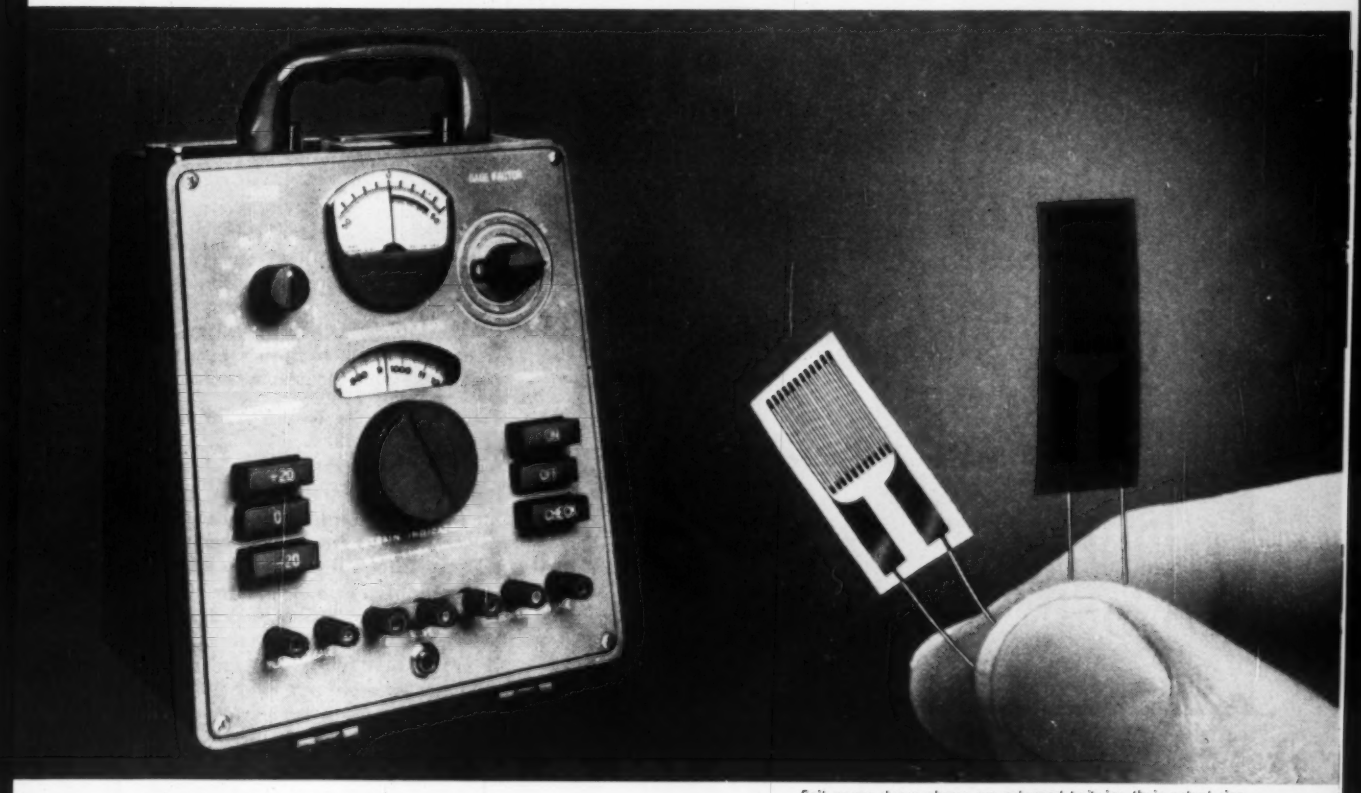
MAXWELL M&M MANNING & MOORE INC. TRADE MARK

INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **56** on inquiry card.

Newest strain-measuring equipment from Baldwin



Foil gages shown above are enlarged to twice their actual size.

NEW SR-4® strain indicator and NEW SR-4 bonded foil strain gages

Type N SR-4 Strain Indicator

This new, improved strain indicator features printed circuits and transistors, weighs one-third less than the previous model and has a smaller case. No warmup is required. In intermittent service its batteries last up to five times as long and cost two-thirds less. The legs of the case are positioned to permit tilting for improved readability. For direct readings with full external bridge, no calibration correction is required. Used as a preamplifier with standard cathode ray oscilloscope, it gives visual indication of dynamic strain with better response and in a broader range than the previous model. Frequencies up to 300 cps at amplitudes up to 3500 microinches per in. can be observed without appreciable distortion.

SR-4 Bonded Foil Strain Gages

Two new types of foil gage in ½ in. gage length, 120 ohms resistance, now make many types of stress analysis possible with new accuracy and ease. A Bakelite-bonded gage, Type FAB-2, and a quick-drying paper-and-cement-bonded gage, Type FAP-2, have marked advantages over comparable standard bonded wire strain gages. Hysteresis is now so low as to be negligible for stress analysis. Fatigue life of the paper gage matches that of comparable wire gages—that of the Bakelite gage is longer. Lateral strain sensitivity of both is down by one-half, offering new accuracy in measuring biaxial strains. The quick-drying paper gage is quick and easy to install. The Bakelite gage offers such attractive features as dependable service at 300°F or higher. It is thinner and more flexible than comparable bonded wire gages—requires no preforming for curved surfaces and is thus easier to apply. Its glass fiber filler makes it less sensitive to moisture effects.

Both new foil gages have tinned lead wires, well anchored and easy to connect. Both gages are now stock items for prompt delivery. For more information on this or other Baldwin stress analysis equipment, write to Electronics & Instrumentation Division of B-L-H, Waltham, Mass. Or we will have a representative call on you at your request.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

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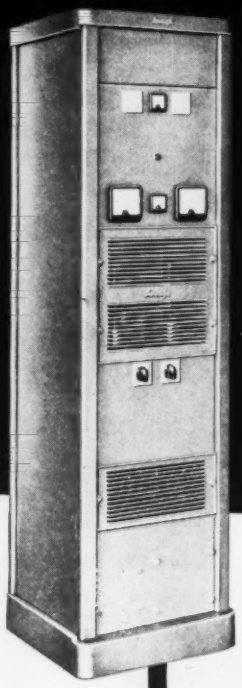
6 cps to 100,000 cps at

1,000 WATTS CONTINUOUS DUTY

...with the new Genisco-Savage high-output amplifiers!



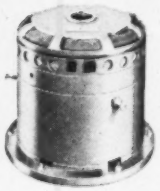
Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19″ vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

Two New Shake Tables Available The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ±600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ±750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.



The Genisco-Savage Model V1000 Shaker

BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM25	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.

Genisco Savage

Genisco, Incorporated
2233 Federal Avenue
Los Angeles 64, California

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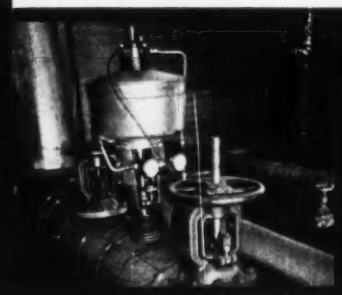
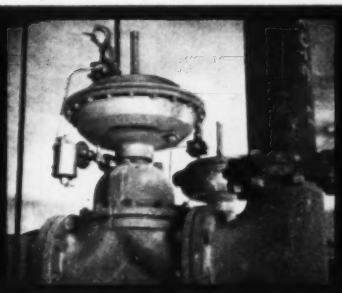
CREATED FOR THE JOB

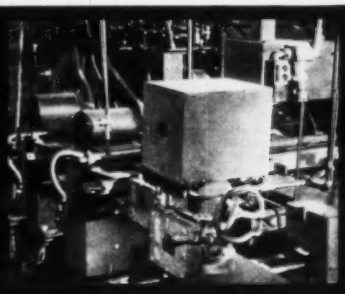
by CONOCONTROLS Specialists



Conoflow LB Valve on a difficult liquid level control job in a Barrett Div. plant of Allied Chemical & Dye Corp. This valve is handling hot coal tar at temperatures to 750° F.

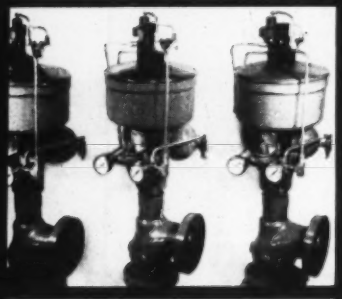


Conoflow Saunders Valves used in conjunction with Fuller Company's Airveyor System in a midwestern cement plant. These close-coupled "on-off" valves are equipped with solenoids and armored position indicators.

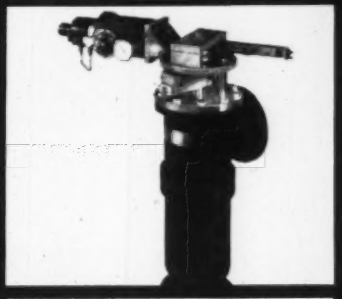


One of several Conoflow Rotomotors on a unique service in Owens-Corning's Newark, Ohio plant. This powerful pneumatic actuator positions a large circular saw which automatically trims and cuts a continuous sheet of Fiberglas into stock widths.

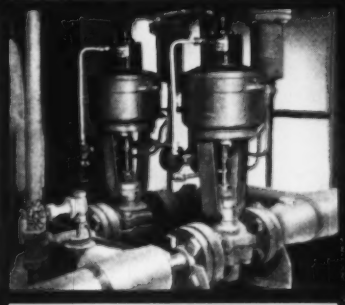
Conoflow Pressure Transmitters for the Kraft Foods Company. They will be used with miniature recorder-controllers to give visual indication and record of levels and pressures in vegetable oil vessels.



These 3" Conoflow "S" Valves are going to the Aluminum Co. of America in the new St. Louis pilot plant. They will be handling hot flashing caustic liquor containing 7% suspended solids with pressure drops up to 300 psi.



Cylinder Conomotor affords remote manual or automatic adjustment of flow rate for a Kates direct-acting flow regulator. This is one of many OEM applications for Conoflow's versatile pneumatic throttling actuator.



These Conoflow LB Valves have been on a tough temperature control service for over three years in the plant of this large manufacturer of floor covering and insulation. More than 600 Conoflow LB Valves are in use throughout this plant.

Conoflow Airpak filter-regulators being tested prior to shipment to duPont. Other large volume Airpak users are: Phillips Petroleum, Leeds & Northrup, Catalytic Construction, Minneapolis-Honeywell, and Fischer & Porter.

While most Conoflow products are shelf items—a good many are not. They are created for the job through our engineering and yours—combined and concentrated on your problem. Shown above are only a few examples of the variety and scope of Conoflow installations. If you are not already a Conoflow customer, phone or write us at 2100 Arch Street, Philadelphia 3, Pa. We'll put you in touch with a Conoflow representative qualified to help you.

Cono-Controls®

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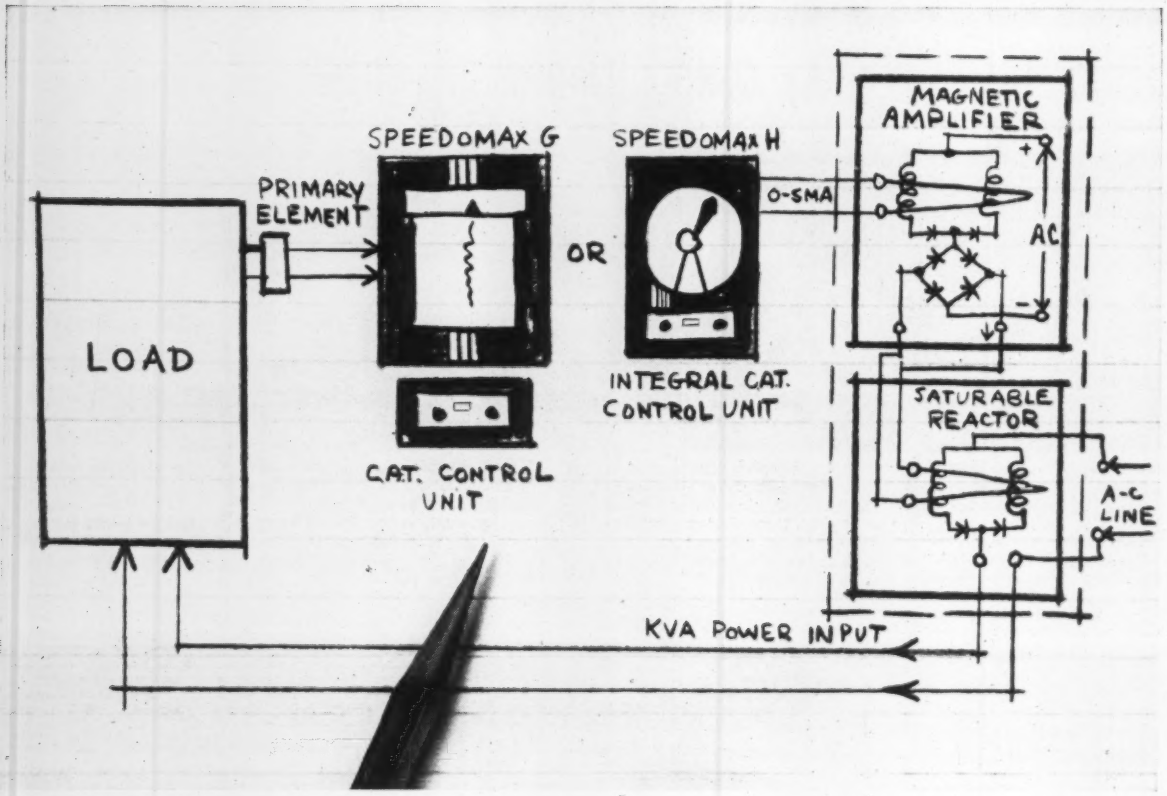

Now...Stepless control of Electric Heat Input with L&N's new C.A.T. control system

If your process uses electric heating equipment and your product is off-temperature due to cycling of heating elements at high temperatures . . . if excessive downtime and expensive replacement of worn-out contacts cut down production time . . . it'll pay you to learn about L&N's new Current-Adjusting Type control for continuous, efficient power output in saturable core reactor systems.

Already in use on applications like crystal growing and strip annealing, this control permits stepless regulation of power output over the *entire operating range of saturable core reactors.* Its rapid speed of response matches rapid changes in product temperature. The wide range of adjustment of proportional, reset and rate actions facilitates tuning the system to your process, product and production.

C.A.T. control is a complete system consisting of (1) a primary element, (2) Speedomax® recorder, (3) C.A.T. control unit, and (4) a magnetic amplifier and saturable core reactor.

Heart of the system is the C.A.T. control unit. Any temperature change, detected by the primary element and measured by the recorder, is fed to the control unit. Continuous d-c output of the unit over 0 to 5 ma range drives a magnetic amplifier. The d-c output of the magnetic amplifier is fed to the control windings of a saturable core reactor for continuous regulation of power input to the process.

If you're modernizing your present electric process equipment or installing new—make use of our wide experience in providing temperature control systems for thousands of applications. For more information, contact your nearest L&N sales office, or write us at 4955 Stenton Ave., Philadelphia 44, Penna. Ask for Data Sheet ND 46-33(107).

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INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—***M. H. Aronson,*** Editor

Editorial

INSTRUMENTATION—1957

1957 was a year of (1) slow but steady progress in most of the established fields of instrumentation, (2) rapid expansion in some of the newer phases of the technology, but (3) re-evaluation of some of the new concepts of instrumentation. The market for established instrumentation (measurement and control of pressure, temperature, flow, composition, etc.) expanded normally and business was good because all segments of national life now realize the essential power and economy of effective instrumentation in research and production. Many of the same trends reported in 1956 continued unabated—particularly use of digital techniques in computation and control. The commercial lines of digital equipment were rounded out with high-speed analog-to-digital converters, high-speed commutators, and high-speed conversion devices that permit optimum use of analog and digital techniques.

Analog computation was mentioned as an important trend in 1956. In 1957 the analog-computer market was about $32 million, but is expected to reach $100 million by 1960; 1957 saw the country's first order from a steel mill (Jones & Laughlin) for an analog computer to simulate operations. Other basic industries are expected to follow this development.

The digital computer market, about $350 million in 1957 (mainly in business applications), also is expanding; for example, more than 1000 orders in a few months after introduction of the new RAMAC (Random Access Machine Accounting) caused IBM to revise its market predictions upwards.

New low-cost lines of infrared spectrometers (about $4000) appeared in 1957, which should expand this market. About 2000 infrared spectrometers are now in the USA.

In nucleonics, emphasis was on test reactors.

Industrial TV (ITV) was another rapidly expanding market in 1957. Only $1 million in 1954, it exceeded $6 million in 1957 and is accelerating in education and industrial applications.

Magnetic tape is still another rapidly expanding field; 1957 sales are running at $12 million per year.

Biggest expansion was in semiconductors. Sales are expected to exceed $100 million in 1957, 82% over 1956 and above all predictions. Transistor sales in 1957 were above $35 million.

Although the fields mentioned expanded nicely, there was re-appraisal of a concept that had impact in 1956—the systems concept whereby one instrument manufacturer assumes responsibility for the entire system owned by the user. Firms at work on such systems began reporting a restricted market and, worse still, large losses and uneconomic conditions on actual jobs. A re-appraisal of the entire concept of having one manufacturer assume the responsibility for the instrumentation of an entire system became necessary as 1957 ended.

Still another re-appraisal became painfully necessary on October 5, 1957—Sputnik day—on which day it suddenly became obvious that another nation, through systematic support of technical education, had passed our country in a basic field of technology. This turned attention to a dramatic education experiment now underway in the Public High School System of Pittsburgh, Penna., whereby the engineers in that area, acting through their local societies and a committee of consultants, had organized an accelerated high-school course in modern technologies—electronics, instrumentation and automation. In the absence of federal aid to education, this experiment can be a practical guide for any school system that wishes to add an accelerated course in modern technologies to its curriculum. Perhaps this was the most significant development in the instrument field in 1957.

Although mankind's first artificial satellite brought out a weakness in the American educational system (not to mention a pitiful lack of foresight on the part of its leaders), it also opened a new instrumentation era. For the first time man has duplicated nature's most magnificent handiwork and has found his pathway open to the stars, a pathway with a multitude of instrumentation problems involving measurement and control of interplanetary navigation, guidance, temperature, radioactivity and communication. The instrument industry is ready for the space era.

ISSUES

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and thereby registers the end of thirty years of *Instruments and Automation's* service to users of measurement and control devices—service to THE UNITED STATES OF AMERICA

The entire staff of *Instruments and Automation* wishes you

Season's Greetings

There are many applications for absolute-value mechanisms—devices that produce an output proportional only to the distance of an input position from an origin, or set point, regardless of the polarity of the input. A pivoting-cam device is described that overcomes the limitations of simple "external V" and "internal V" absolute-value mechanisms.

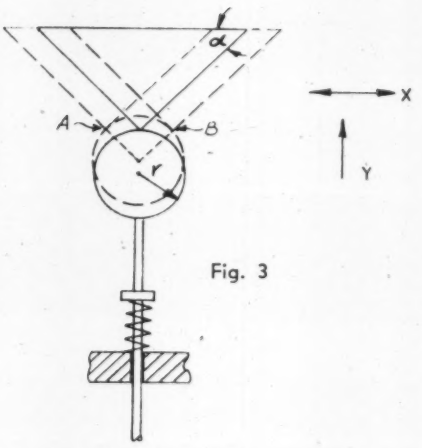


Fig. 3

Fig. 2

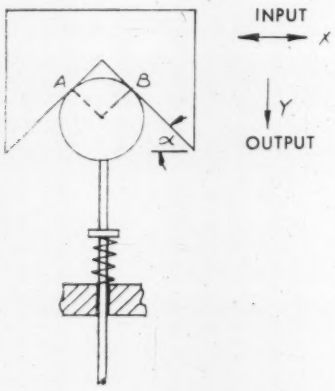
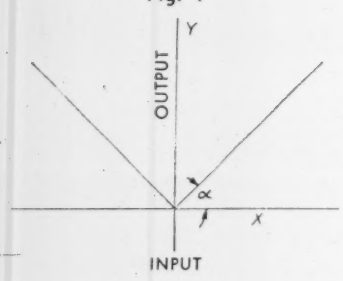


Fig. 1



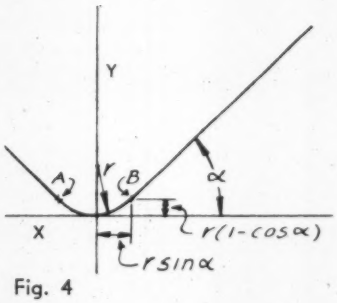


Fig. 4

SHERMAN Z. DUSHKES
Redwood City, California

Absolute-Value

OBTAINING the absolute valve of a variable X, or |X|, by simple mechanical means often is required in servomechanisms having mechanical error data systems.[1]

V-Block Devices

One proposed solution is an internal V-block mechanism (Fig. 2). This will produce a true absolute-value characteristic such as shown in Fig. 1. It solves the equation $Y = K|X|$ where Y represents the output, X represents the input, and K is a constant of proportionality. (Note: Downward movement of follower is positive Y.) However, at point $Y = 0$ in Fig. 2, the roller follower will contact the cam at two points, A and B. This produces a wedging or locking action and the mechanism will jam at the center position when X is changing at a moderate rate with respect to time.

Another possible V-block configuration—an external V-block—is shown in Fig. 3. This device will not produce a true absolute value characteristic, but instead will produce a rounded characteristic (Fig. 4) that is unacceptable.

Pivoting Cam

A successful device (Fig. 5) comprises a pivoting flat-face cam and roller follower.[2] The cam pivots about a bearing point in a cage; the left-to-right position of the cage represents the input deviation. Fixed stops in the cage determine the two limiting positions which the cam can occupy for positive and negative values of the input. The vertical position of the follower represents the output.

The radius of the roller follower is equal to the pivotal radius of the cam. Thus the pivot point of the cam and the center of the roller follower coincide at the origin point. When the cage is displaced to the right or left of this (0,0) point, the upward force of the spring-loaded follower will cause the cam to swing to one or the other limit position, depending on the sign of the input. The two limit positions of the cam

[1]"Variable Pressure Hydraulic Servomechanisms" by Sherman Z. Dushkes, *Machine Design*, October, 1955, p 171-175.

[2]Patent No. 2,743,619.

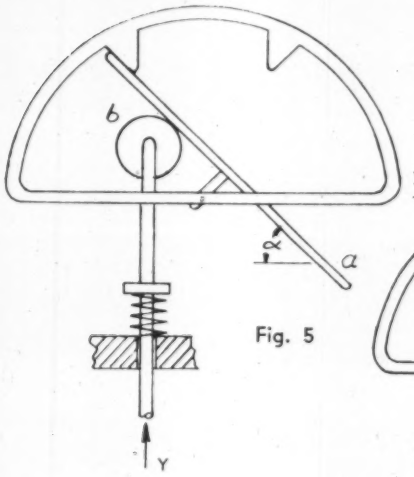
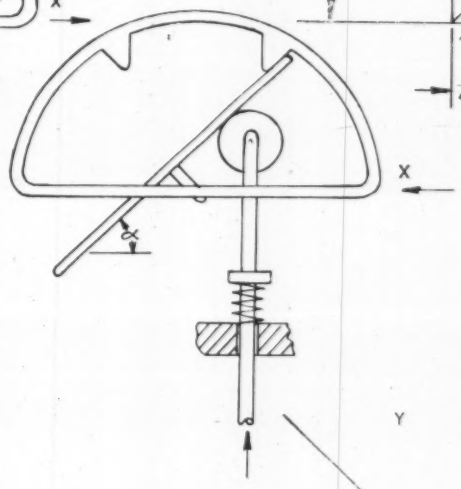


Fig. 5



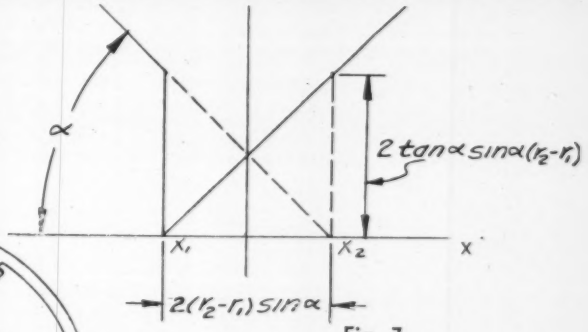
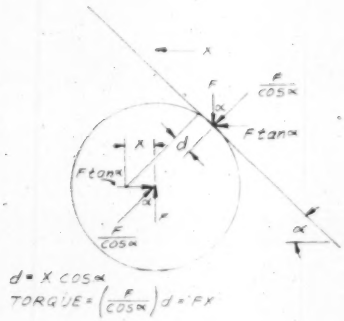


Fig. 7



◀ Fig. 6

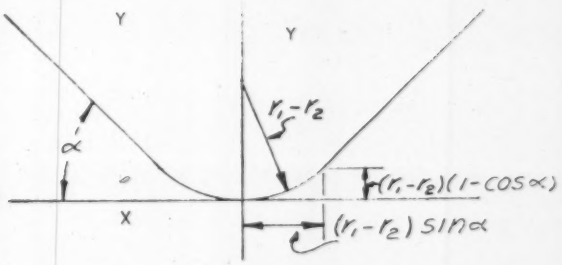


Fig. 8 ▶

Mechanisms

determine the slope of the cam, and hence the slope of the two legs of the characteristic curve (Fig. 1). When the cam stops are set so that α equals 45° the value of K, which is tan α, is 1, and $Y = |X|$. The important advantage of the pivoting-cam mechanism over the internal V-block mechanism is that the roller follower can contact the pivoting cam only at one point, thereby eliminating the jamming action (and the associated shock loads) that occur in the internal V-block mechanism.

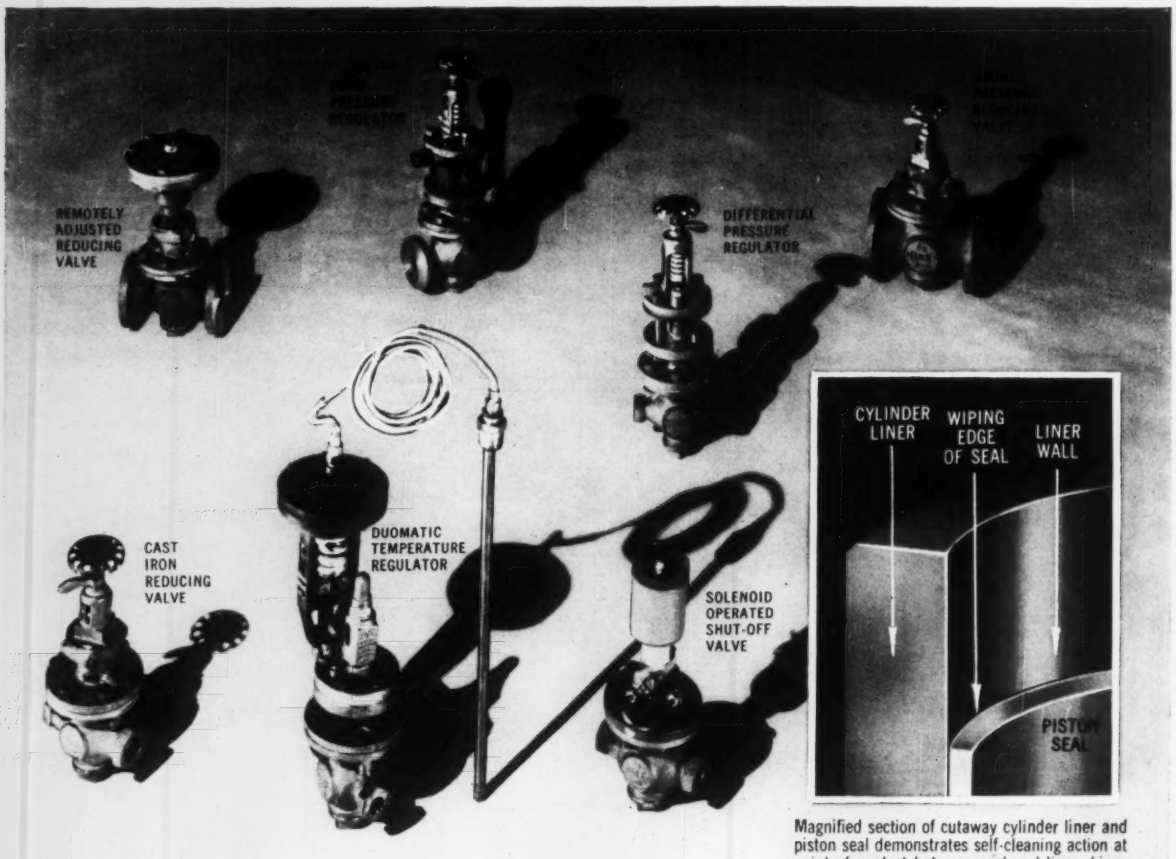
Hysteresis

As the cam passes through the origin (0,0 position), a slight displacement between the center of rotation of the cam and center of the roller follower is required in order to generate a torque to flip the cam from one limit position to the other. The applied torque is equal to the spring force multiplied by the lateral displacement between the two centers (Fig. 6), and the amount of torque required to initiate motion depends on bearing sticking friction. This gives rise to a hysteresis effect (Fig. 7). A rounding of the hysteresis portion of the characteristic curve occurs as the cam is rotating while the cage is moving. The extent of this rounding is a function of cam inertia, bearing viscous friction, and time-rate-of-change of X. The total hysteresis can be made small by using a suitably large spring force. For example, one model of this device developed complete cam rotation from one to the other limit position within 0.003″ of either side of the origin (total cam travel was approximately ±2″). In the ideal case the cam rotation would occur at the origin with instantaneous rolling of the cam about the follower.

Modifications

If the pivotal radius of the cam is less than the radius of the roller follower a substantial hysteresis will be generated that cannot be reduced by increasing follower spring force. This hysteresis effect is defined by equation $2(r_2 - r_1) \sin \alpha$, as shown in Fig. 7.

If the pivotal radius of the cam is less than the radius of the follower, the characteristic again will be rounded in the vicinity of the origin, such as shown in Fig. 3. In this case the cam can be at equilibrium at intermediate angles between the two limit angles when the input is in the vicinity of the zero. These aberrations increase proportionally with the difference in radii between the roller follower and pivoting cam (Fig. 8).



Magnified section of cutaway cylinder liner and piston seal demonstrates self-cleaning action at point of contact between seal and liner. Liner wall is swept clean of contamination deposits.

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The continuous "wiper" action of the new piston's seal keeps the cylinder liner clean, improves reliability, reduces maintenance.

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Data Sheet RV-51C — Instructions for converting your present Leslie Regulator to self-cleaning piston type

Bulletin 5302-B — Reducing Valves and Pressure Regulators

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Proper application of the proper type of safety device requires knowledge of the types available, and ingenuity in foreseeing all possible causes for trouble. Here are the available types.

Safety and Relief Valves

FRED D. MARTON, Instruments & Automation
and
CHESTER S. BEARD, General Controls Co.

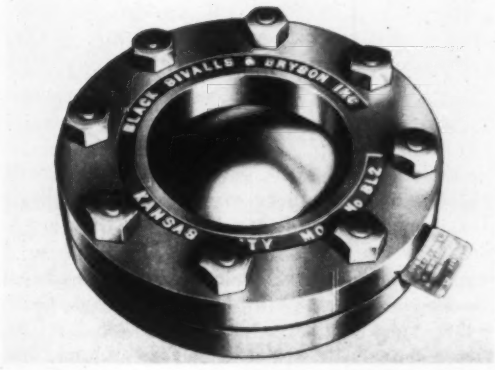


Fig. 8-1. Typical rupture disc.

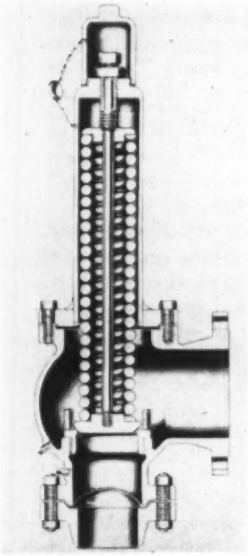


Fig. 8-2. Rupture disc used with a safety-relief valve.

SAFETY AND RELIEF valves can be classified as regulators—that is, control devices that require no external source of power for operation.

The purpose of a safety valve is not to regulate a pressure within certain limits (as do back-pressure regulators, described earlier) but to bring about a rapid and radical change once a preset pressure in the system is reached. Some basic terms used in connection with safety valves are given in Table 8-1.

Types of Pressure-Relieving Devices

There are four basic types of safety devices—rupture disc, safety valve, relief valve, and safety-relief valve.

The simplest safety device is a *rupture disc* (Fig. 8-1), which is merely a thin metal sheet designed to burst when pressure exceeds a given value. It is held between flanges and inserted either in the wall of a pressure vessel or in a line connected to the vessel. It is also referred to as a *frangible disc.*

As given in Table 8-1, the safety valve pops full open at a preset pressure. This popping action is caused by the *huddling chamber* shown in Fig. 8-3. When the valve is closed, the line pressure acts against a small area of the huddling-chamber disc. As soon as the disc begins to move away from the seat (or as soon as line fluid leaks past the seat), owing to increase in line pressure above the set pressure, the line pressure acts on a larger area and forces the valve wide open, suddenly. Some safety valves use a reaction chamber rather than a huddling chamber.

The blowdown ring shown in Fig. 8-3 can be raised or lowered by rotating it. This varies the relieving gap and also changes the point at which the valve reseats.

Table 8-1.—Safety and Relief Valve Terminology

Safety Valve: A safety valve (Fig. 8-3) is a device that "pops" full open at a preset pressure to allow a large volume of steam, gas, or vapor to pass through and then closes promptly when the pressure is reduced to a normal value. It is used on steam, gas or vapor service.

Relief Valve: A relief valve (Fig. 8-4) does not pop full open; it opens automatically in proportion to the increase in pressure over the set pressure. It is used primarily for liquid service. Some types have full or semi-nozzle.

Safety-Relief Valve: A safety-relief valve (Fig. 8-5) can be adjusted to give either "pop" or "non-pop" operation, and can be used on steam, gas, vapor, and (with modifications) liquid service. It is characterized by a nozzle or semi-nozzle.

Relieving or Popping Pressure: The pressure at which a relief valve *starts* to open at the operating temperature, or at which a safety valve pops open.

Set Pressure: The difference between relieving pressure and back pressure on valve. When no back pressure exists, set pressure is identical with relieving pressure.

Maximum Relieving Pressure (a term sometimes used in refinery calculations): Relieving pressure plus accumulation in psig.

Accumulation (or Overpressure): Amount by which set pressure may be exceeded at full-flow conditions (safety or relief wide open).

Blowdown: Difference between the opening and closing pressures.

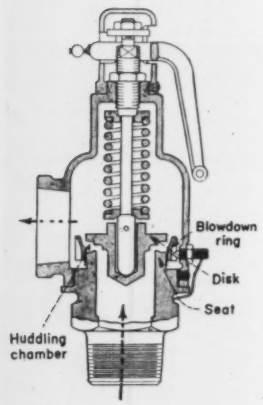


Fig. 8-3. Safety valve pops open at overpressure and closes when pressure returns to normal. It is used on gas or vapor service. Some types have full or semi-nozzle.

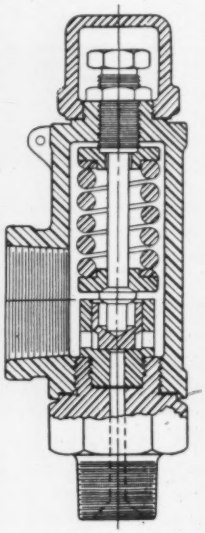


Fig. 8-4. Relief valve does not pop open but opens gradually. It is used on liquid service.

The *relief valve* (Fig. 8-4) differs from the safety valve in that it has no pop action, and is used primarily for liquid service.

The *safety-relief valve* (Fig. 8-5) is a universal device in that it can be adjusted to give either pop or non-pop operation, and also can be used on any service.

Where the excessive pressure is maintained by, say, a leak into the system or by a continuing fire, the safety valve will open and close repeatedly, at a *rate* which depends on the capacity of the safety valve. An oversized safety will open and close rapidly—that is, it will chatter. A properly sized safety valve will open and close at a slower rate. (By contrast, in steam-service pressure reduction, an oversized *regulator* will just crack open and close rapidly, leading to wire drawing of the seat and chatter of the valve, whereas a properly sized regulator will not chatter at all.)

Pop Action on Liquid Service

On liquid service, a safety valve with a standard huddling chamber will not pop open; rather, it will open like a relief valve, requiring 25% overpressure to open the valve fully. However, valves with specially designed huddling chambers are provided by manufacturers so that pop action results on liquid service. It is only rarely that pop action is required on liquid service, but it can be obtained.

Safety Codes

The importance of safety devices to the public welfare is reflected in the many codes issued by federal, state, and local authorities which stipulate their applications.

Four major codes have been drafted by Engineering Societies, and are known by society name. There are other codes that are used and are stipulated by various industries: Associated Factory Mutual Fire Insurance Companies, Interstate Commerce Commission, Chlorine Institute, American Association of Railroads, U. S. Coast Guard, Bureau of Marine Inspection and Navigation (BMIN), and others. Two of the four major codes are for heated or "fired" vessels (such as steam boilers), and two are for so-called "unfired" pressure vessels, as follows:

Safety Codes—Fired Vessels

(1) The *ASME* Power Boiler Code, 1952 Edition*, stipulates the use of *safety valves of the spring-loaded type* for pressure over 15 psig, and covers boilers, drums, superheaters, reheaters, and turbines. Use of dead-weighted-lever safety valves is ruled out.

(2) The *ASME Low-Pressure Heating Boiler Code* covers steam boilers for pressures under 15 psig, and hot-water vessels. The code uses the term "safety and relief valves," and also includes rupture discs.

Safety Codes—Unfired Vessels

(3) The *ASME Unfired Pressure Vessel Code*, 1952, covers unfired steam boilers such as heat ex-

*American Society of Mechanical Engineers

changers, and other unfired pressure vessels such as compressed-air reservoirs or liquid-filled vessels, and stipulates the use of "safety and relief valves" of the spring-loaded type.

(4) The *API*-ASME Unfired Pressure Vessel Code,* 1951, is similar to the preceding code and includes unfired pressure vessels for petroleum liquids and gases.

Safety Valves

Safety valves are for gas or vapor service and must pop full open. They are made in two different basic designs—(1) the wing-guided type and (2) the top-guided nozzle construction. They are actuated by the upstream static pressure and characterized by rapid full-opening "pop" action.

The wing-guided or disc-guided type (Fig. 8-6) has been in use for ninety years and is characterized by a low-lift huddling chamber and bottom guiding by wings. Now used only occasionally for liquid service, it is not as common as top-guided types. The huddling chamber, for pop action, is formed either by an adjustable blowdown-ring or a mechanical equivalent. The set point can be varied plus or minus 10%; various springs are used to cover the full range.

The top-guided safety valve (Fig. 8-7) was pioneered over thirty years ago and has lead to many refinements. In contrast with the wing-guided type it is characterized by *high-lift* developed by means of venturi action of the nozzle. As the lift required to fully uncover any circular port (so that the flow through the resulting cylindrical area equals the open port area) is one quarter of the port diameter, the capacity of this type of safety valve is equal to a nozzle of the same size blowing direct to atmosphere. Coefficients of discharge** of up to 97.5% have been proved by "National Board Certification of Boiler and Pressure Vessel Inspectors" tests for this type.

Note that a semi-nozzle, rather than a full nozzle is used in Fig. 8-7. Here the nozzle is short and does not protrude beyond the flanged or screwed connection.

Safety valves (as well as relief and safety-relief valves) are made with side outlet or top outlet, and always should be installed with the stem in vertical position. Adjustment of the blowdown ring is necessary when the set point is altered. This adjusts the amount of steam the valve will relieve, and also the point at which it reseats.

Valves for air and gas can be installed in an inverted position to allow moisture to collect and seal the seating surfaces. For gases, side outlets are preferred so that the discharge can be piped away.

Safety valves of the lever-and-weight type (Fig. 8-8) are not suitable for air or water service but find application in low-pressure steam-relief service where a simple, inexpensive valve will suffice. The levers usually are graduated for pressures of, say, 15 to 40 psig, or 41 to 100 psig. They have large blowdown (difference between opening and closing pressure), low

*American Petroleum Institute

**Coefficient of discharge equals actual flow/theoretical flow.

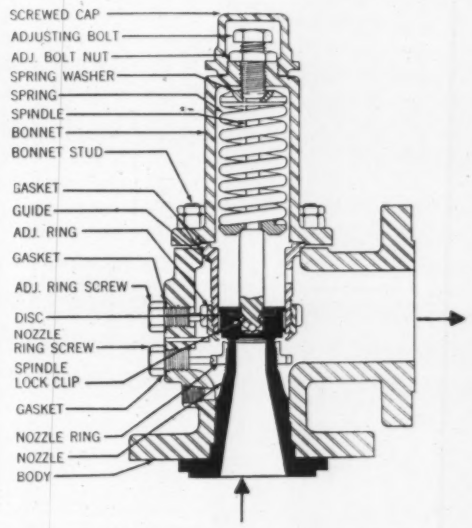


Fig. 8-5. Safety-relief valve can be used on either vapor or liquid service as either a safety (pop-action) or a relief valve. Reaction chamber rather than huddling chamber is used.

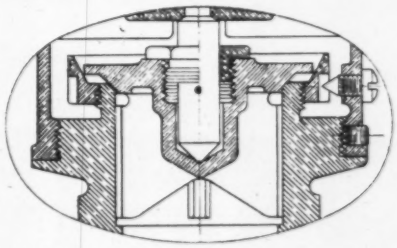


Fig. 8-6. Wing-guided construction is not used as much as top-guided type.

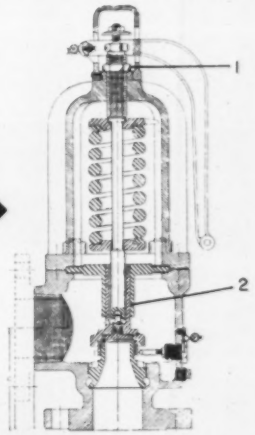
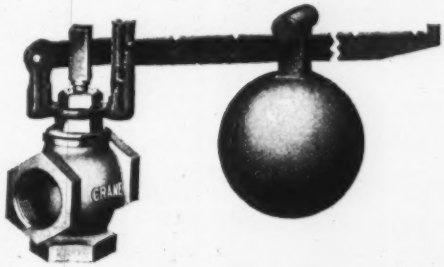


Fig. 8-7. Top-guided semi-nozzle safety valve has high life and high efficiency. Stem is guided both at point 2 and by extending through nut at top at point 1.

Fig. 8-8. Lever-and-weight safety valves are used in some low-pressure steam-relief services.



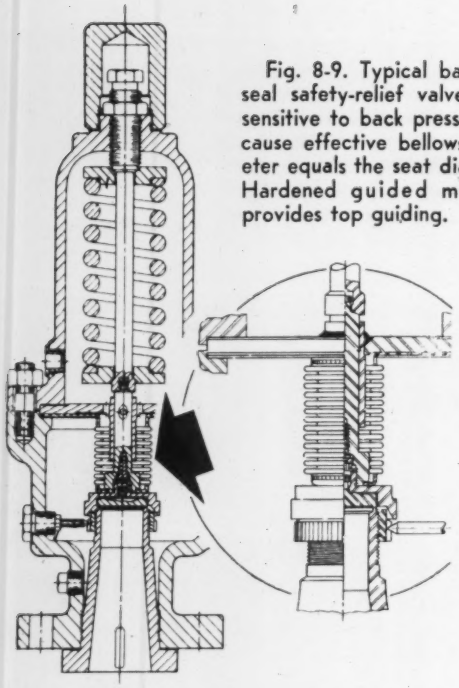


Fig. 8-9. Typical balanced-seal safety-relief valve is insensitive to back pressure because effective bellows diameter equals the seat diameter. Hardened guided member provides top guiding.

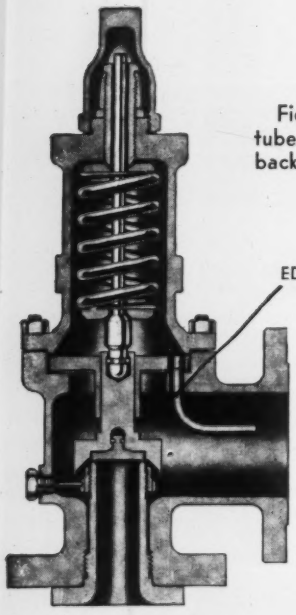


Fig. 8-10. Use of eductor tube to reduce the effect of back pressure.

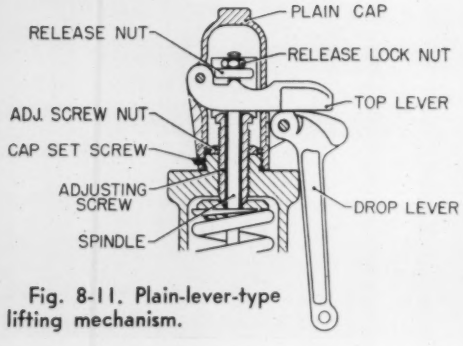


Fig. 8-11. Plain-lever-type lifting mechanism.

capacity, and no positive opening and closing point—all undesirable characteristics.

Relief Valves

Relief valves (Fig. 8-4) open in proportion to the overpressure. They are used mainly in liquid service and in non-coking refinery service. They also can be used on air compressors and with steam and vapors where exacting performance is not required. They normally have no blowdown ring, except when used in steam and gas service. Similar types are also used for vacuum relief. They are not recommended as unloading valves or to relieve shock pressures in hydraulic lines. For air or gas compressor service, valves of this type should be used only where a blowdown (pressure differential) of 10% or more is permissible; otherwise, use of a pop-type safety valve is indicated.

Safety-Relief Valves

The valve referred to by most manufacturers as "safety-relief" is made as a venturi-nozzle type (Fig. 8-5) and is characterized by high lift and high capacity because it must meet exacting requirements in steam boiler service and in refinery, chemical, industrial and process plants.

The safety-relief valve usually has a nozzle (Fig. 8-5) or semi-nozzle (Fig. 8-7) inlet. The venturi action of the inlet nozzle results in high kinetic efficiency—that is, the escaping vapor or liquid strikes the valve disc with high velocity, giving positive action throughout the high lift of the disc.

The semi-nozzle type in small sizes is usually made from bar stock for high pressure; it can be made also from material suitable for corrosive service.

The safety-relief valve is the most used safety device and has undergone considerable changes and refinements since it was first put on the market, including incorporation of stainless-steel bellows to prevent corrosive media from contacting moving parts. Free fluid flow, high capacity, easy maintenance, and smooth performance are characteristics of this type of valve.

Back Pressure

Valves discharging into a closed blowdown system (instead of into the atmosphere) operate against back pressure in the discharge manifold. The problem has been subject of much study and controversy in the last ten years. Where several valves relieve into a manifold the first one to blow will create an unpredictable back pressure in the system which will prevent the other valves from relieving at the proper set pressure. To play safe, refinery engineers often oversize the discharge piping to minimize the effect of back pressure.

Nozzle-valve construction requires long, small-diameter top guiding (usually at a $2\frac{1}{2}$:1 ratio) which produces problems of sticking, freezing of viscous liquids, corrosion, etc., and difficulties in getting the valve to seat itself properly to avoid leakage. Where solids are entrained, as in slurries, valve seats or discs of rubber synthetics are used. When pressures are high, seats of hardened material are required.

The back-pressure problem became more involved with the advent of valves sealed by bellows to protect the internal guiding surfaces of the valve, spring, and spring chamber from corrosive effects of the flowing medium. Here the spring rate of the bellows adds to the main spring and must be taken into consideration.

The first bellows-protected valves, which were put on the market about a decade ago, were designed to enable standard valves to be converted by adding the bellows. Because of mechanical space limitations the relationship of the bellows' effective area to the seat area must vary with the valve size and orifice. Hence this convertible design compensates only partially for variations of back pressure.

Newer designs of bellows-seal valves (Fig. 8-9) avoid this difficulty by a "balanced" design in which the effective area of the bellows is exactly equal to the area of the seat. The inside of the bellows is at atmospheric pressure, thus back pressure has no influence on the relieving point of the valve and practical back pressures up to 80% are permissible. With balanced valves smaller sizes of discharge piping can be used.

Fig. 8-10 shows the use of an "eductor" tube to hold the pressure in the valve bonnet close to atmospheric pressure, so that only the spring force controls the valve.

Lifting Mechanisms and Design Considerations

All major codes call for periodic testing of safety and relief valves *for steam and air service*. They stipulate that an appropriate lifting device shall permit opening of the valve at 75% of the pressure at which the valve is set to blow. The lifting mechanisms are usually made in three designs—(1) plain lever (Fig. 8-11), (2) packed lever in which no leakage can occur when the lever is used (Fig. 8-12), and (3) air-operated devices including diaphragm motors (Fig. 8-13).

Safety and relief valves for services other than steam and air need not be provided with a lifting device, although a lifting device is desirable for vapors that are not hazardous.

Other design considerations concern the connections, which can be screwed, flanged, or welded. Combinations of these connections are used frequently.

Vacuum Relief

On tanks storing volatile liquids, combination pressure and vacuum relief valves are used (Fig. 8-14). They are usually made in large sizes (up to 20") and have vacuum settings from ½ oz per sq in to 8 oz per sq in. Three types of loading are used—spring, deadweight, and lever-and-weight. Emergency pressure-relief vents have even lower settings—of the order of a few inches of water column (Fig. 8-15).

Combination Pressure/Temperature Relief Valves

To protect hot-water heaters from the hazards of overpressure and/or boiling temperature, small valves

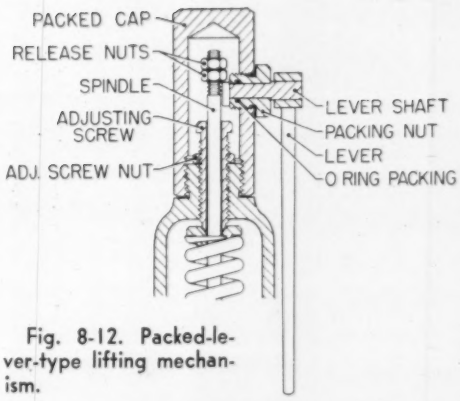


Fig. 8-12. Packed-lever-type lifting mechanism.

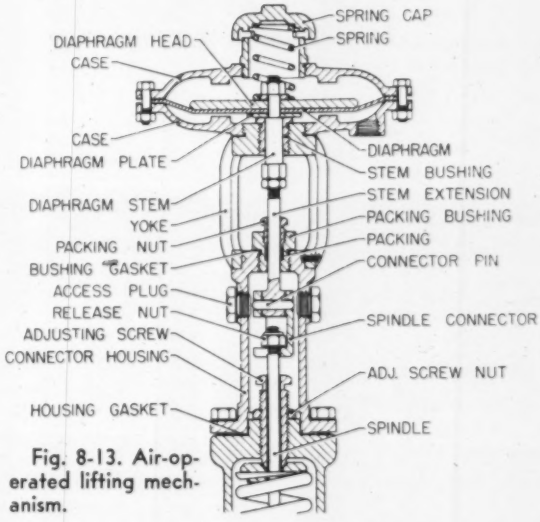


Fig. 8-13. Air-operated lifting mechanism.

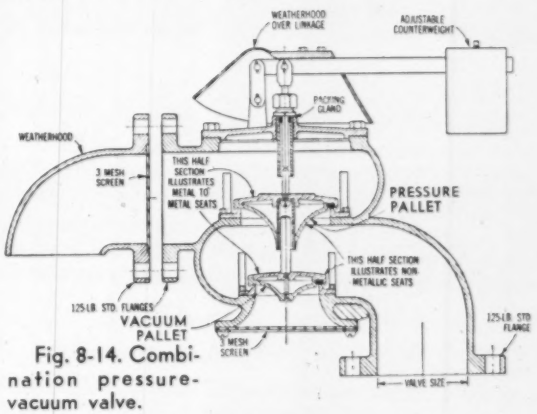


Fig. 8-14. Combination pressure-vacuum valve.

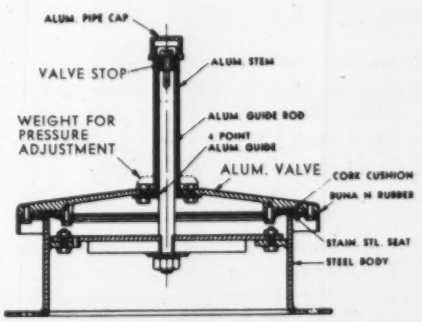


Fig. 8-15. Emergency pressure-relief vent can be set to open at a pressure of a few inches of water.

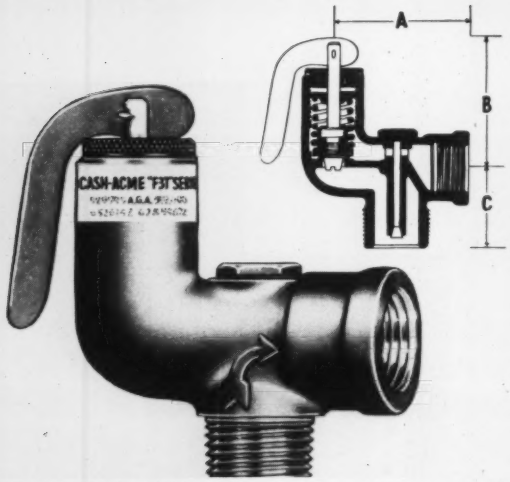


Fig. 8-16. Combination pressure/temperature relief valve.

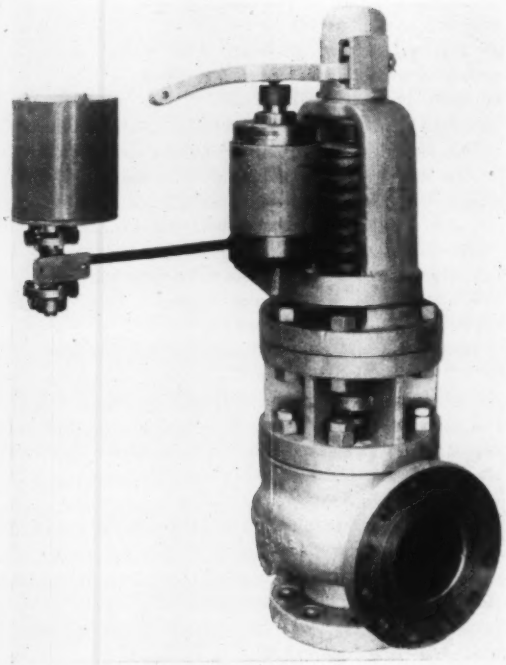


Fig. 8-17. Turbine overspeed safety device.

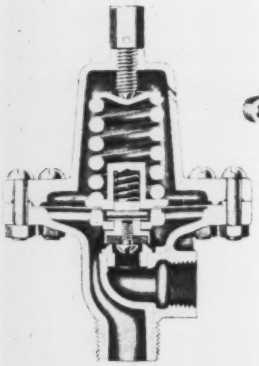


Fig. 8-18. Relief valve with diaphragm.

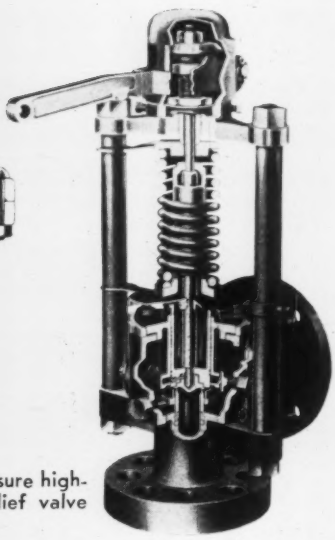


Fig. 8-19. High-pressure high-temperature safety-relief valve for steam service.

(½" x ½" or ¾" x ½") are used (Fig. 8-16) which have a fuse plug that melts at 210°F. The plug can be replaced easily without disconnecting or disassembling the valve.

Safety Valve for Protection Against Turbine Overspeed

On loss of turbine load, overspeed of the low-pressure turbine can occur should the intercept valve fail to close. In this case an air-lift cylinder, controlled by an overspeed switch on the turbine, opens the reheat-header safety valve, thus removing the cause of the overspeed (Fig. 8-17).

Diaphragm Relief Valves

Relief valves can be built with diaphragms of synthetic rubber, inert plastics (like Kel-F), or stainless steel which isolate spring and guides from the line fluid (Fig. 8-18). Such valves are especially suitable for slurries, corrosive gases, or chemical service. Large-size diaphragms increase the sensitivity, and the valve will open with only a slight pressure rise.

High-temperature Operation

One of the chief factors affecting popping point is the temperature of the mechanism. Heat expands the loading mechanism, thereby unloading the spring; it also weakens the spring, further lowering the popping point on successive pops.

Fig. 8-19 shows a high-pressure high-temperature safety-relief valve for steam service. The body is designed so that the frame rods and spring are not heated by the high-temperature steam when the valve operates, and thus the spring rate remains constant. This permits use to high temperatures, and the set pressure does not change with repeated popping.

Another advantage of the unit shown in Fig. 8-19 is that the unit can be disassembled and seats can be checked without loosening the spring and disturbing the set point. This eliminates the need for trial popping and resetting. Also, nozzle-ring and guide-ring adjustments can be made while the valve is under pressure; the valve can be completely serviced while in the line and under pressure.

Acknowledgement

Photos and drawings are by courtesy of Black, Sivalls & Bryson (Figs. 8-1 and -2); A. W. Cash Mfg. Corp. (Fig. 8-16); Crane Co. (Fig. 8-8); Crosby Valve & Gage Co. (Figs. 8-5 and -17); Farris Engineering Corp. (Figs. 8-3, -4, -6, -7, and -9); Foster Engineering Co. (Fig. 8-19); Johnston & Jennings (Fig. 8-15); Manning Maxwell & Moore, Inc. (Consolidated) (Figs. 8-10, -11, -12, and 13); Mueller Co. (Fig. 8-18); and Vapor Recovery Systems Co. (Fig. 8-14).

Interpretation of

RECENT EVENTS IN THE AUTOMATION FIELD

RICHARD RIMBACH

Instruments Publishing Company

THE subject of this discussion is "An Interpretation of Recent Events in the Automation Field." I would like to define "events" as the emergence of trade journals, technical societies, meetings, and exhibitions, and I would like to define "recent" as the last thirty years, because it was then that one of the first significant events in the field occurred. This was the publication, in January, 1928, of the monthly magazine *Instruments*.

Publications

Permit me to tell you a little about the field now known as the field of instrumentation and automation thirty years ago, when I published Vol. 1 No. 1 of *Instruments*. The words "instrumentation" and "automation" were unknown; it was "the instrument field." Before the appearance of the first issue I spoke to two vice-presidents of a large technical publishing house with many technical magazines serving many industrial fields. They assured me that the instrument field was so restricted and insignificant that they would *never* bring out a publication in that field. Today they have a publication in the field, brought out 27 years later.

I spoke also to the executives of many instrument manufacturers. Their attitude was generally one of surprise that anybody could be rash enough to gamble on the tiny field of instruments, particularly industrial instruments. A few progressive firms supported this pioneering venture—but just enough to sustain the nation's first publication in the field through two decades of the roughest type of pioneering.

In the next year, 1929, another instrument magazine appeared on the market, the *Review of Scientific Instruments*. It had been started in 1922 as a section in the *Journal of the Optical Society of America*.

In the 23-year period from 1929 to 1951, these two publications were the only ones in the USA devoted to instrumentation. Their combined circulation was about 15,000.

This relatively static situation ended in 1951, when *Computers and Automation* began publication, signifying the emergence of the computer as an important instrumental tool.

By 1953 it was obvious that the groundwork laid during the previous two decades was beginning to pay off. Interest in instrumentation and automation began to grow rapidly, as evidenced by numerous papers, articles, talks, symposia, etc. The time appeared ripe for truly mass coverage of the field.

Thus, in 1953, *Instrument & Apparatus News* appeared with a distribution in excess of 90,000. Its success was almost instantaneous. Interest in the field now became general. No fewer than five publications appeared in the United States in 1954—*The ISA Journal* and the *Journal of the Association for Computing Machinery* in January; *Automatic Control* in July; *Automation* in August; and *Control Engineering* in September.

Since 1954, only one new publication has appeared in the instrument field—*Military Automation*, which began publication in 1957.

From this brief history of publications, it appears that the field experienced two decades of slow but steady growth, followed by a few years of accelerated growth, and is now back to normal steady progress. I predict that the only new publications to come into this field will be specialty type magazines, devoted to groups that normally do not read technical publications other than their own. For example, medical men of the U. S. A. are, as a group, unaware of the power of instrumentation. I am pleased to make the first formal announcement of the planned publication *Medical Electronics News*, which will serve medical workers and specialists beginning July, 1958.

To those who think that there are too many publications in our field, I would like to point out that most of these publications do NOT overlap in function. Some are society journals, which perform an entirely different function from the technical trade publications. Among the technical magazines, one is devoted primarily to materials handling and "Detroit-type" of automation, one is primarily an instrument designers' magazine, another is primarily a users' magazine. Thus each performs a different function, and each renders a needed service. The new publication *Medical Electronics News* will serve medical specialists who do not read any other instrument publication. Thus each new publication contributes to the instrumentation field.

Table 1 shows a list of the American, Australian and British publications exclusively devoted to instrumentation, automatic control and automation. Almost every engineering and technical periodical has articles

(Read before the Twelfth Annual Meeting of the Instrument Society of America, Cleveland, September 13, 1957)

Table 1—Publications Devoted to Instrumentation and Automation in the United States, Australia and England

	Started Publication	Address	Issues/year	Price in U.S.A.
U.S.A.				
Instruments & Automation	1928*	845 Ridge Ave., Pittsburgh 12, Pa.	12	$4.00
Review of Scientific Instruments	1929**	335 E. 45 St., New York, N. Y.	12	$9.00
Computers and Automation	1951	815 Washington St., Newtonville 60, Mass.	12	$5.50
Instrument & Apparatus News	1953	845 Ridge Ave., Pittsburgh 12, Pa.	6	Controlled
Automatic Control	1954	430 Park Ave., New York, N. Y.	12	Controlled
Automation	1954	Penton Bldg., Cleveland, Ohio	12	Controlled
Control Engineering	1954	330 W. 42 St., New York, N. Y.	12	$5.00
I. S. A. Journal	1954***	313 6th Ave., Pittsburgh, Pa.	12	$4.00
Journal Association for Computing Machinery	1954	2 East 63 St., New York, N. Y.	12	$10.00
Military Automation	1957	845 Ridge Ave., Pittsburgh 12, Pa.	6	Controlled
AUSTRALIA				
Australian Journal of Instrument Technology	1945	422 Collins St., Melbourne	4	42 sh
ENGLAND				
Journal of Scientific Instruments	1923	47 Belgrave Square, London, S.W.1	12	105 sh
Instrument Practice	1946	9 Gough Square, London, E.C.4	12	50 sh
Transactions, Society of Instrument Technology	1949	80 Bishopgate, London E.C.3	4	50 sh
Process Control & Automation	1954	30 Furneval St., London E.C.4	12	30 sh
Instrument Review	1955	27 Craven St., London W.C.2	12	50 sh
Automation & Automatic Equipment News	1955	9 Gough Square, London E.C.4	12	20 sh
Automation Progress	1956	Stratford House, 9 Eden St., London N.W.1	12	50 sh

*Was started as INSTRUMENTS in January 1928 and changed to INSTRUMENTS & AUTOMATION in January 1954.

**Was started as a section of the Optical Society Journal in 1922 and became a separate Journal in 1929.

***Was started as a section in INSTRUMENTS in October 1946 and began as a separate Journal in January 1954.

on measurement and automatic control, but only those primarily concerned with the subject are included in Table 1. House organs of instrument manufacturers or consultants are not included.

Table 2 shows the Continental publications in the field. You will see that overseas developments in technical publications in this field are not unlike our own. The total is 45 known publications in this field.

Societies, Conferences and Exhibitions

The growth of the field also is evident from the history of its exhibits, conferences, technical societies and trade associations.

Let us exclude the instrument company booths at the Power Shows, Chemical Shows, Machinery Shows, etc., and consider only the shows devoted exclusively to instruments and automation.

The first society devoted to measurement and control was the Southern California Meter Association. On July 14, 1927, twelve men met and founded the SCMA, which now has a membership of 650. The *Journal of the SCMA* appears monthly in *Instruments & Automation*.

The first U. S. Conference on Instrumentation in the Steel Industry was arranged by the writer at the Carnegie Institute of Technology, Metallurgical Department, in October, 1938. A small exhibit was held in conjunction with this conference. In March, 1939, the first Conference on Instrumentation in the Process Industries was held, and in October, 1945, the Conference on Instrumentation in the University was held, both also at Carnegie Tech.

In August, 1942, the writer organized the first of the Annual Research Conferences on Instrumentation of the American Association for the Advancement of Science at Gibson Island, Maryland.

Instruments' Editor M. F. Behar and the writer were active in the organization of another instrument group in this country—The American Society for Measurement and Control—in 1939, and subsequently assisted in the organization of many other groups which, in conjunction with the American Society for Measurement and Control, became the Instrument Society of America in April, 1946.

In 1945, with the co-operation of many members of the American Society for Measurement and Control, the writer organized in Pittsburgh the First National Instrument Conference and Exhibit. Wartime travel restrictions caused its postponement from September, 1945, to September, 1946.

Table 2—Continental Publications Devoted to Instrumentation and Automation

	Started	Publication Address	Issues/year	Price in U.S.A.
CZECHOSLOVAKIA				
Mereni A Regulace	1957	Praha XIV, Englova 1411		
FRANCE				
Mesures et Controle Industriel	1936	79 Avenue de Champs Elysees, Paris 8	12	2,900 fr.
Automation	1956	6 Rue de Liege, Paris 9	12	600 fr.
Automatisme	1956	92 Rue Bonaparte, Paris 6	12	2,800 fr.
GERMANY				
Zeitschrift fuer Instrumentenkunde	1881	Verlag Fr. Vieweg & Sohn, Braunschweig	12	40 D. M.
Feinwerk Technik*	1893	Fuessen, Bayern	12	40 D. M.
Archiv fuer Technisches Messen	1931	Rosenheimer Str. 45, Munich 8	12	38.40 D. M.
Feingeraete Technik	1952	Unter den Linden 12, Berlin N.W.7, (East Germany)	12	36 D. M.
Regelungstechnik	1953	Rosenheimer Str. 45, Munich	12	45.60 D. M.
Technische Informationen Feinmechanik und Optik	1953	Maschstrasse 42, Braunschweig	12	48 D. M.
Automatik	1956	Heimhuderstrl 53, Hamburg 13	12	38.00 D.M.
Industrielle Automatisierung	1956	Postfach 6014, Heidelberg	6	18. D. M.
HUNGARY				
Meres es Automatika	1953	V. Honved Ucca 22-14, Budapest 195		
ITALY				
Strumentazione e Automazione	1953	via Marcona 15, Milan	12	8000 Lire
I 'Automazione	1955	Piazza A. Diaz 2, Milan	6	
JAPAN				
Keisoku (Instruments)	1951	Instrument Society of Japan, c/o Faculty of Engineering, University of Tokyo, Tokyo	12	$4.00
Jidoseigyo (Automatic Control)	1954	Society of Automatic Control, c/o Institute of Industrial Science, University of Tokyo, Chiba-Shi	4	$3.00
POLAND				
Pomiary, Automatyka, Kontrola	1955	Czackiego 3/5 Strytka, Pocztowa 360, Warsaw I	12	144 zl.
RUMANIA				
Metrologia Aplicate	1956	Str. Stirbei Voda 186 Bucharest	12	
Automatica si Electronica	1957	Str. Ion Ghica Nr. 3, Bucharest	12	
RUSSIA				
Awtomatika i Telemekhanika**	1936	Academy of Sciences U.S.S.R., Moscow	12	$12.00
Awtomatika	1956	Akademia Nank Ukrainskoj RSR, wul. Czkalowa 556/Institut Elektrotechniki Ak. Nank, Kiew (Ukraine)		$3.50
Priborostroenie	1956	Moscow, B-66, Spartakovskaya ul. d. 2a, komn. 288	12	$5.00
Awtomatika, Telemekhanika i Svyaz'	1957	Moscow, Novo-Basmannaya Ul. No. 2 (Ministry of Railroads)	12	
Pribory i Tekhnika Eksperimenta	1956	Moscow, B-234, Leninskie gory, MGU, Fizicheskiy fakultet, Krioghennyy korpus	6	$8.00
Izmeritel'naya Tekhnika	1955	Moscow, K-1, ul. Shchuseva 4	6	$4.00
SPAIN				
Calculo Automatico y Cibernetica	1952	Conde de Penalver, 19, Madrid	3	90 pesetas
SWITZERLAND				
Microtecnic	1947	Avenue de la Gare 23, Lausanne	6	$12.00

*Was called Der Mechaniker from 1893 to 1912; Zeitschrift fuer Feinmechanik from 1913 to 1930; Feinmechanik und Praezision from 1931 to 1944

**An English translation is published regularly (beginning with Vol. 17, 1956) by Consultants Bureau, Inc., 227 West 17 St., New York 11, New York.
Subscription $185.00 for 12 issues

At the Instrument Exhibit in St. Louis, in 1950, the writer arranged the first of the annual Instrument Maintenance Clinics, which have since been a regular feature of Instrument Society Exhibits.

In September, 1954, the writer organized the First International Instrument Exhibit and in November of the same year the First International Automation Exposition.

Table 3 lists the technical, engineering and scientific

Table 3—Technical, Engineering and Scientific Societies in the Instrument & Automation Field.

AMERICAN

American Institute of Electrical Engineers, Science and Electronics Division: Computing Devices Committee, Automation and Data Processing Committee; Instrumentation Division: Indicating and Integrating Instruments Committee, Electronic and High Frequency Instruments Committee, Special Instruments Committee, Telemetering Committee, Nucleonic and Radiation Instruments Committee, Aircraft and Flight Test Instrumentation Committee; General Applications Division: System Engineering Committee; Power Division: Feedback Control Systems Committee, 29 West 39 St., New York 18, New York

American Society of Mechanical Engineers, Instruments & Regulators Division, 29 West 39 St., New York 18, New York

American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Association of Computing Machinery, 2 East 63 St., New York 21, New York

DDA (Digital Differential Analyzer) Council, 3023 Alcott St., San Diego 6, California

Institute of Radio Engineers, Professional Groups devoted to Automatic Control, Electronic Computers, Industrial Electronics, Instrumentation, Telemetry and Remote Control, and Medical Electronics, 1 East 79 St., New York 21, New York

Instrument Society of America, 313 Sixth Ave., Pittsburgh, Pa.

Simulation Council 8484 La Jolla Shores Drive, La Jolla, California

Society for Non-Destructive Testing, 1109 Hinman Ave., Evanston, Illinois

Society of Photographic Instrumentation Engineers, 7668 Beverly Blvd., Los Angeles 36, California

Southern California Meter Association, 10219 Orange Ave., South Gate, California

AUSTRALIA

Australian Society of Instrument Technology, Melbourne

Institute of Instrument Technology, Sidney

BELGIUM

Institut Belge de Regulation et d'Automatisme, 3 Rue Ravenstein, Brussels

Association Internationale de Cybernetique, 13 Rue Basse-Marcelle, Namur

International Society for Analog Computation, Brussels

CHINA

Chinese Association of Electronics, Peking, 3 Wun Ching-Chieh

ENGLAND

Society of Instrument Technology, 20 Queen Anne St., London, W. 1

Institution of Electrical Engineers, Measurement & Control Section, Savoy Place, London, W.C.2

FRANCE

Association Francaise de Regulation et d'Automatisme, 19 Rue Blanche, Paris 9

Federation Nationale de l'Automation, 13 rue de Liege, Paris (9e)

GERMANY

Fachgruppe Regelungstechnik, Verein Deutscher Ingenieure/Verein Deutscher Elektrotechniker Duesseldorf (Prinz-Georg-Strasse 77/79)

Normenarbeitsgemeinschaft fuer Mess-und Regeltechnik in der Chemischen Industrie, Leverkusen-Bayerwerk

HOLLAND

Koninkligk Institut van Ingenieurs, Sectie voor Regeltechnick

HUNGARY

Merestechnikai es Automatizalasi Tudomanyos Egyesuelet, Budapest V. Honved utca 22

ITALY

Associazione Nazionale Italiana per l'Automazione, Piazza A. Diaz 2, Milan

Consiglio Nazionale delle Ricerche, (Commissione de Studio per l'Automazione) Piazzale delle Scienze 7, Rome

JAPAN

Keisoku-Kondankai, c/o Faculty of Engineering, University of Tokyo, Tokyo

Society of Automatic Control, c/o Institute of Industrial Science, University of Tokyo, Chiba-Shi

RUSSIA

Vsheshouznii Obshestvo Priborostroenya, Moscow, ul. Volhonka d. 5.

SPAIN

Sociedad Espanola de Cibernetica, Conde de Penalver 19, Madrid

SWITZERLAND

Schweizerische Gesellschaft fuer Automatik, Sternwartstrasse 7, Zurich

societies in this field; Table 4 lists the Trade Associations.

There are instrument exhibits at industry shows which in some cases are larger than the shows devoted solely to instruments. For example, at the German Chemical Show, Achema, about 160,000 sq ft of exhibit space is devoted to industrial and laboratory instruments.

Table 5 is a list of some of the shows in this field.

Economic Growth of the Industry

After many discussions with the Bureau of the Census, the instrument and automatic control industry was recognized by the U. S. Census of Manufactures in 1947 when it created industry classification "38—The Instrument Industry." Even now there are many facets of the industry which are not included in this industry classification.[1] However, the Census indicates that the industry volume in 1954 was $3.7 billion, compared with $3.1 billion in 1952.

Other indications of growth are shown in Table 6 that lists the number of new products reported in *Instruments & Automation* since the first volume in 1928. In this table you will also see the number of companies whose products are listed in the *Instruments & Automation Buyers' Guide.*

[1]The Instrument Industry, An Economic Report, Richard Rimbach, *Instruments & Automation*, June, 1957, Pages 1122-1125.

International Meetings and Exhibitions

There are a multitude of regional, national, and international meetings and exhibitions devoted to instrumentation as well as to the allied fields of automatic control, cybernetics and computing. On the average of once a week we have meetings, seminars and exhibitions on instrumentation and automation. It has been claimed that this has entailed a great deal of overlapping and duplication both in time and treatment. At a recent meeting a representative of the American Institute of Electrical Engineers reported that notices of 51 computer meetings had crossed his desk in the first 6 months of this year.

While it is impossible to attend even a fraction of these functions, it is better for the advancement of instrumentation and automatic control to make no effort to reduce the number of such meetings or exhibits. The advancement in this field will be more rapid without restraining efforts. Each of these meetings contributes to general and specific areas of the field.

What is needed is better program management so that speakers either talk technology or review thoroughly. It is debatable whether the many discussions on the subject of automation and employment, automation and leisure, etc., contribute anything of value—and they do alarm the public. But the greater the number of technical papers delivered, in improved quality, the faster our field will expand.

Table 4—Trade Associations in the Instrument, Automatic Control & Automation Field.

UNITED STATES OF AMERICA

Fluid Controls Institute, Inc., c/o Continental Equipment Co., Coraopolis, Pa.

National Association of Scale Manufacturers, 1129 Vermont Ave., Washington, D. C.

National Electrical Manufacturers Association, 155 East 44 St., New York, N. Y.

Radio-Electronics-Television Manufacturers Association, 11 W. 42 St., New York 36, New York

Recorder-Controller Group, Scientific Apparatus Makers Association, 522 Fifth Ave., New York, New York

Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago, Illinois

CANADA

Scientific Instrument Manufacturers' Association of Canada, c/o Polytronics Co., Toronto 4

ENGLAND

British Industrial Measuring & Control Apparatus Manufacturers' Association, 21 Tothill St., London, S. W. 1

British Pressure Gauge Manufacturers' Association, Steelhouse Lane, Birmingham

British Radio Valve Manufacturers' Association, 16 Jermyn St., London, S. W. 1

British Chemical Ware Manufacturers' Association, Ltd., 19 Portland Place, London, W. 1

British Clock & Watch Manufacturers' Association, 35 Northampton Square, London E.C.1

British Electrical & Allied Industrial Research Association, Perihelion, West End London

British Lamp Blown Scientific Glassware Manufacturers, 19 Portland Place, London W.1

Gauge & Tool Makers' Association, Old Bond St., Standbrook House, London, W. 1

Radio & Electronic Component Manufacturers' Association, 21 Tothill St., London S.W.1

Scientific Instrument Manufacturers' Association, 20 Queen Ann St., London, W. 1.

FRANCE

Syndicat de la Robinetterie (Manometres et Thermometres) 11 Avenue Hoche, Paris 8

Federation Nationale des Syndicates des Industries Radioelectriques et Electroniques, 23 Rue de Lubeck, Paris 16

Chambre Syndicale des Constructeurs, de Compteurs, Transformateurs de Mesure et Appareils Electriques et Electroniques de Mesure et de Controle, 11 Rue Hamelin, Paris 16

Syndicat General de l'Optique et des Instruments de Precision, 11 Avenue Hoche, Paris 8

Chambre Syndicate des Fabricants d'Appareils de Regulation et de Controle Industriel, 10 Avenue Hoche, Paris 8

Chambre Syndicale Nationale de la Mecanique de Haute Precision, 37 Avenue de Breteuil, Paris 15

Syndicat National des Constructeurs d'Appareils Electriques et Electroniques, de Mesure et d'Automatisme, 49 Bd Berthier, Paris 18e

GERMANY

Verband der Deutschen Feinmechanischen und Optischen Industrie, Habsburgerring 2-12, Cologne

Zentral Verband der Elektrotechnische Industrie (The following sections: (1) Fachverband Messgeraete und Zaehler, (2) Fachgruppe fuer Messwesen, (3) Fachunterband Elektronische Messgeraete (4) Fachabteilung fuer Schaltanlagen, (5) Fachabteilung fuer Elektrische Messtechnik, (6) Fachabteilung fuer Fernmeldetechnik (7) Fachabteilung fuer Elektromedizin) am Hauptbahnhof 12, Frankfurt a/M

Fachgemeinschaft Pruefmaschinen, Hansa Allee 321, Duesseldorf, Oberkassel

ITALY

Associazione Nazionale Industriali dell'Ottica, Meccanica Fine e di Precisione, ASSOTTICA, Piazzetta Umberto Giordano 2, Milan

Associazione Nazionale Imprese Produttrici e Distributrici Energia Elettrica, ANIDEL (Commissione N. 26 per l'Automazione) via Dalmazia 15, Rome

Associazione Nazionale Industrie Elettrotecniche, Anie, via Donizetta 30, Milan

Associazione Nazionale Costruttori Macchine per Ufficio, via Rossitti 17, Milan

Unione Costruttori Italiani Macchine Utensili, via G. Giardino, 4, Milan

HUNGARY

Muszeripari Igazgatosag, Budapest V., Oktober 6 utca 7

POLAND

Elktrim, Polskie Towarzystwo Handlu Zagranicznego dla Elektrotechniki, Czackiego 15/17, Warsaw 1

Varimex, Polskie Towarzystwo Handlu Zagranicznego, Wilcza 5/52, Warsaw

Conclusions

1. At the economic level, a healthy and rapid growth can be predicted for the instrumentation industry. By 1967 it may exceed a $15-billion value of goods shipped annually.

2. Sociologically, there is one consistently unifying concept underlying all the activities enumerated—as well as other "recent events" which may have been inadvertently omitted. All have made, and will continue to make, substantial contributions to a better life, with less drudgery, through greater use of instruments and automation.

Table 5—Exhibits and Expositions

Instrument Society Exhibition (Twelfth), September 9-13, 1957, Cleveland, Ohio

International Automation Exposition (Fourth), June 9-13, 1958, New York, New York

International Instruments, Electronics & Automation Exhibition, April 16-25, 1958, London

Internationale Ausstellung fuer Messtechnik und Automatik "Interkama", (First), November 2-10, 1957, Duesseldorf, Germany

Mostra Internazionale dell'Automatismo, April 8-May 20, 1956, Milan, Italy

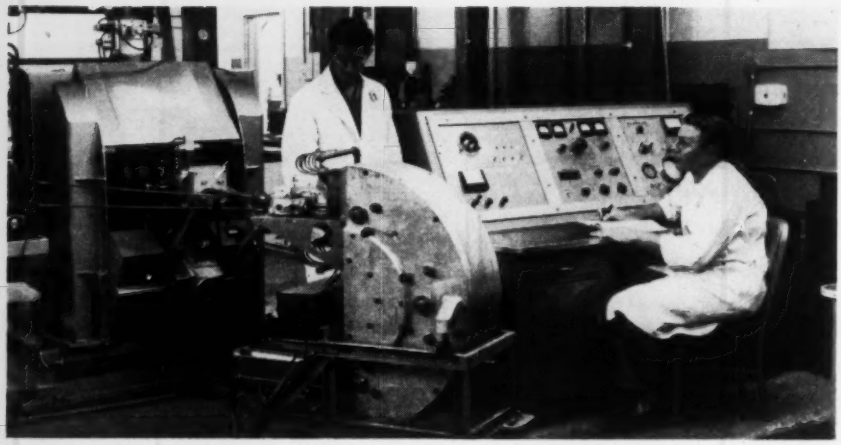
Physical Society Exhibition (Forty-first), March 25-28, 1957, London, England

Measurement and Instrumentation Exhibition, October 1958, Budapest, Hungary.

Table 6. New-Products Reported Annually In *Instruments & Automation*, and Number Of Companies In Field

Year	Products	Companies
1928	84	
1929	106	
1930	133	
1931	233	
1932	283	
1933	308	
1934	311	
1935	306	692
1936	317	
1937	313	
1938	370	
1939	363	854
1940	291	843
1941	246	933
1942	266	964
1943	280	1013
1944	312	1044
1945	393	
1946	647	1264
1947	660	1307
1948	636	
1949	798	1361
1950	1063	
1951	791	1517
1952	1141	
1953	1675	1889
1954	2304	
1955	1900	2569
1956	2068	3371*

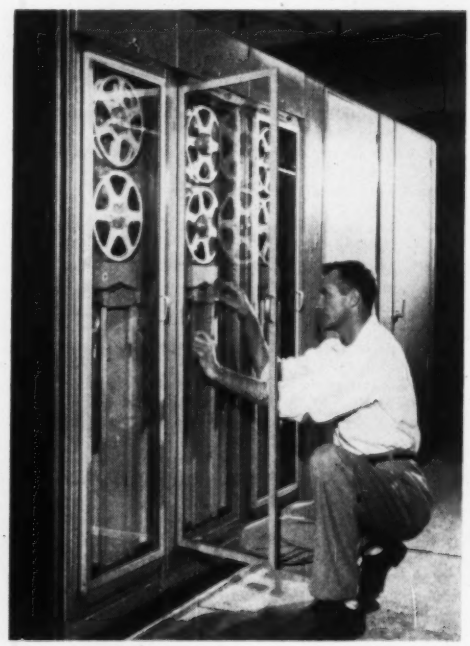
*Includes companies formerly in the Instrument Manufacturing Buyers' Guide.



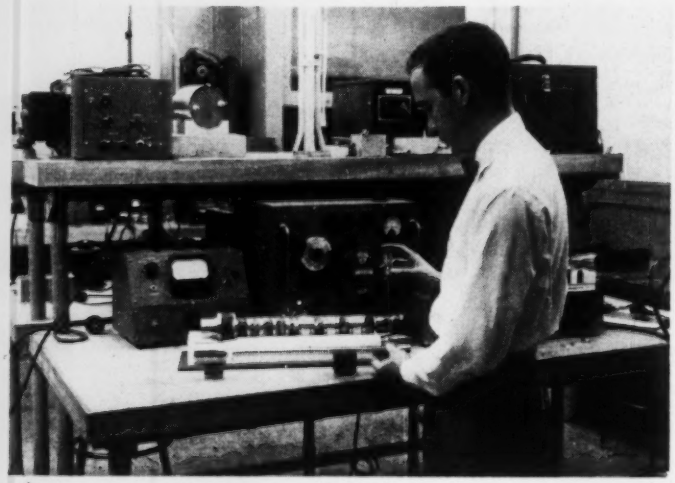
2-MEV VAN DE GRAAFF accelerator, designed and built at SRI, is employed principally for the non-destructive testing and studying of surfaces. The ion-scattering analyzer has been used to locate otherwise undetectable trace elements on metal surfaces.

Research ⇄ Instrumentation

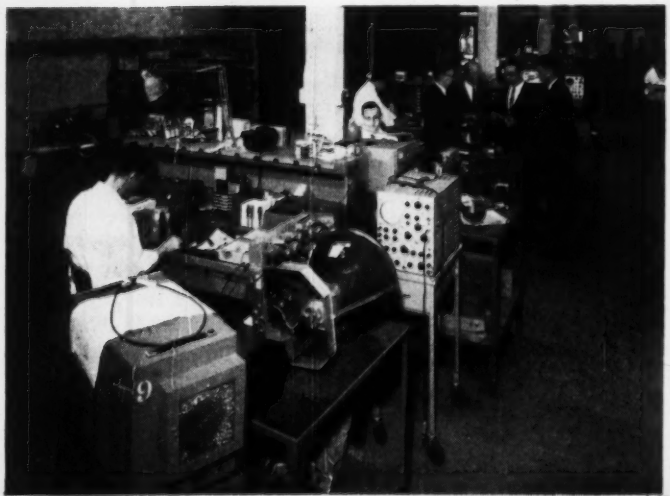
STANFORD Research Institute, Menlo Park, Calif., is an independent non-profit corporation. It has a staff of over 1000 and performs contract research in excess of $10 million annually. Here are some views of SRI laboratories and facilities.



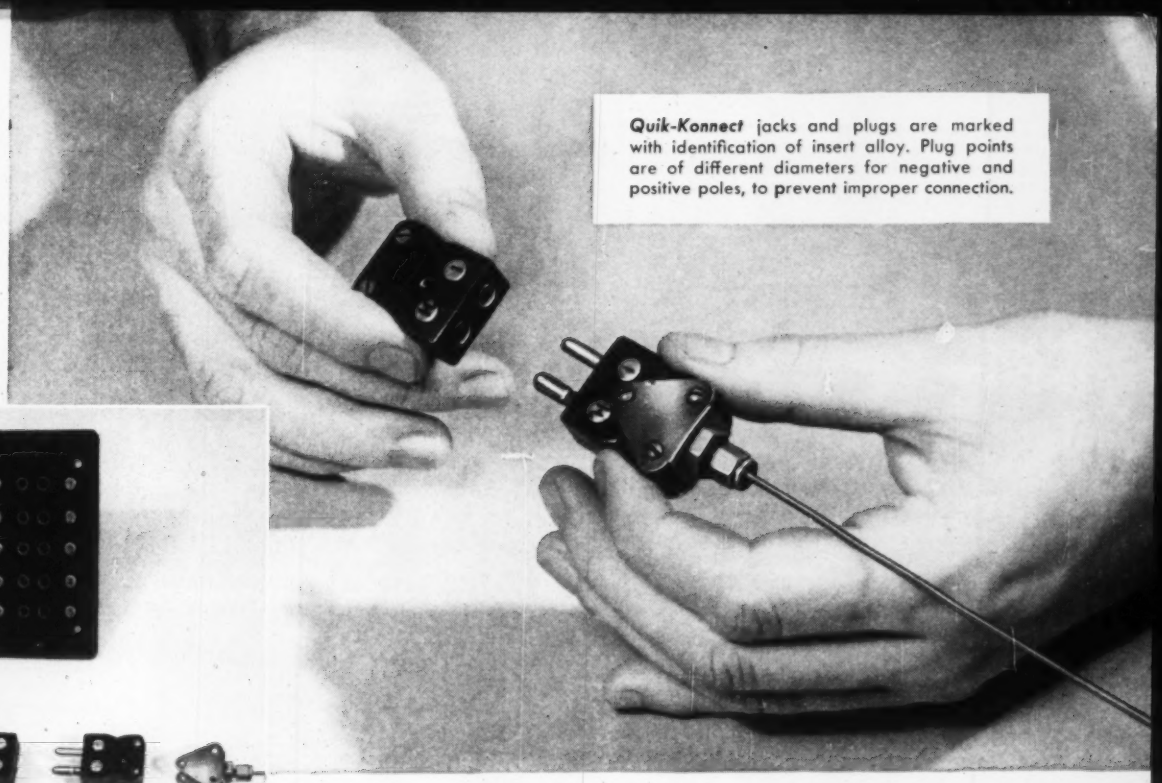
DETAILED ACCOUNT activity information is "filed" by ERMA (a bookkeeping computer developed at SRI) on 10 reels of magnetic tape, each almost half a mile in length.



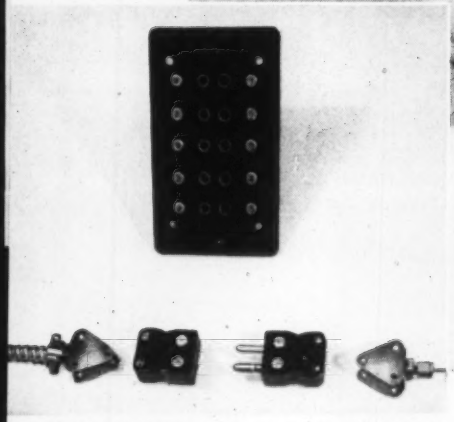
ENGINEER CONNECTS INPUT coaxial line to helix within glass envelope of traveling wave tube built at SRI. The Institute has conducted considerable research into the field of klystron and traveling wave tube designed in its Electron Devices Laboratory.



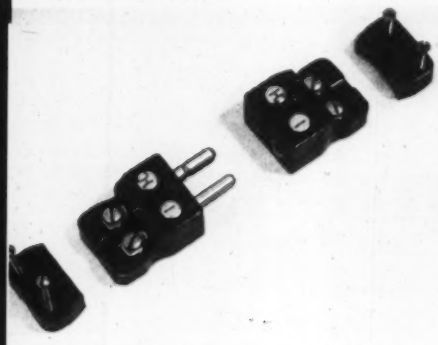
TELEVISION LABORATORY has research programs dealing with transistors for color TV, band-width conservation studies, radar recording, and camera scanning applications in a rapid duplicating process for printed material.



Quik-Konnect jacks and plugs are marked with identification of insert alloy. Plug points are of different diameters for negative and positive poles, to prevent improper connection.



The ***Quik-Konnect*** Components consist of (left to right) cable clamp, jack, plug, and tube connector, and (above) jack panel which can be mounted in conduit box or control panel.



Only the terminal cover at the rear of the connector need be removed during connection of wires.

Honeywell's new *Quik-Konnect** Thermocouple Components cut installation time 75%

. . . available through your HSM HONEYWELL SUPPLIES MAN

WITH these new *Quik-Konnect* Components you can make single, multiple or selective manual connection of a group of couples to an instrument. No handling of small parts. No confusing snarls of loose wire.

All assemblies are integral units. You can use them for quick extension wire connections in a laboratory or test cell, or for convenience and certainty of proper connections in permanent or semi-permanent installations.

Plug and jack assemblies have inserts or points made from the thermocouple alloys to which they should be connected. Available in four standard T C combinations. For complete details, call your nearby HSM (Honeywell Supplies Man). He's as near as your phone; or write for S005-1 specification sheet.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

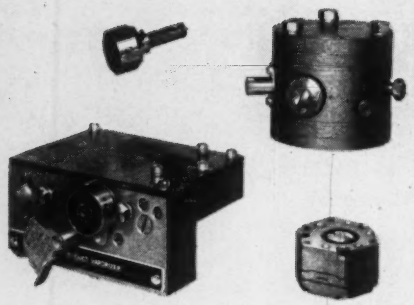
H HONEYWELL

MINNEAPOLIS **Honeywell**

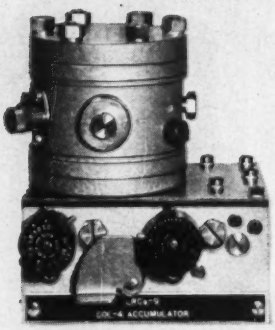
BROWN INSTRUMENTS

First in Controls

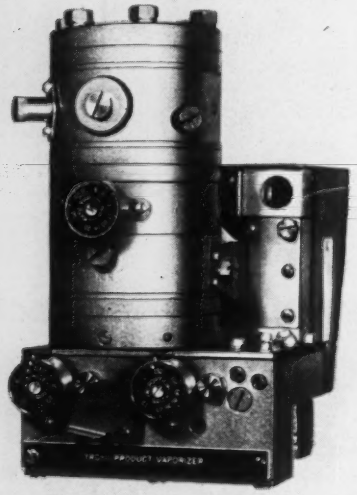
*Trade name of Minneapolis-Honeywell Regulator Co.



Easily disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.



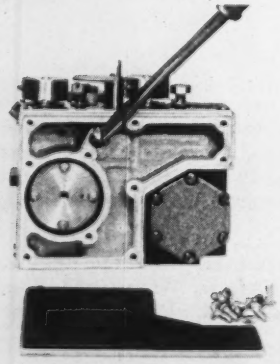
Easy accessibility—All adjustments, filters, and restrictions are easily reached on the face of the controller. Control action is reversed by turning reversing plate 90 degrees.



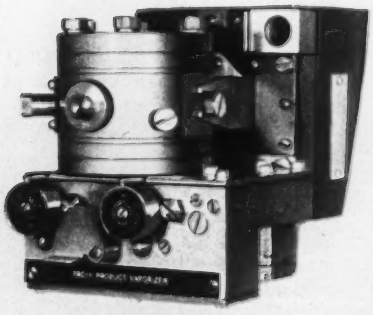
Rate action easily added—Add rate action simply by removing deviation section, inserting longer studs and rate unit, and replacing deviation section.

Save

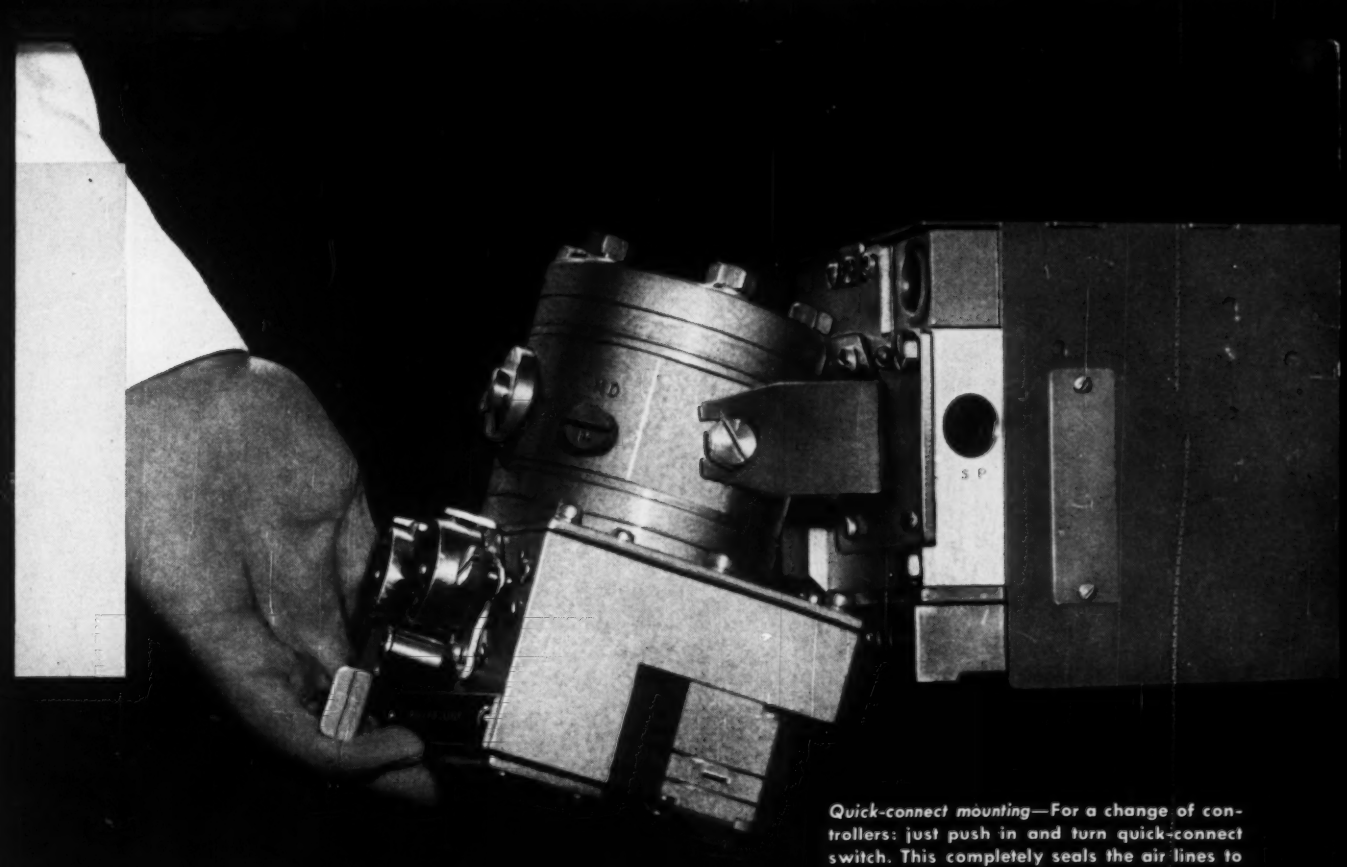
with the simplicity of



Three ranges of reset rates—Move a single sealing screw for choice of three reset ranges: 0.2-100, 0.01-5, or 0.04-20 repeats per minute.



Field-mounting manifold—Furnished for installations where controller is not mounted on the recorder. Has same quick-connect arrangement as rear of recorder, and external reset feedback or bypass relay for bumpless transfer from automatic to manual control.



Quick-connect mounting—For a change of controllers: just push in and turn quick-connect switch. This completely seals the air lines to the controller, permitting removal of the unit while process remains on manual control.

TEL-O-SET* controllers

New and improved *Tel-O-Set* controllers are low in cost, easily installed, compact, and require minimum maintenance. You can use them to control any process variable. One basic model serves for all applications. You can mount the controller anywhere: rear of receiver case, back of panel, or on the valve.

With all their simplicity, these instruments are highly sensitive and respond instantly to change. They operate on a pneumatic-balance principle which eliminates lost motion and friction.

Tel-O-Set controllers are an ideal complement to *Tel-O-Set* recorders and indicators... today's most advanced miniature instruments. For details, call your nearby Honeywell sales engineer. He's as near as your phone.

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Honeywell

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First in Controls

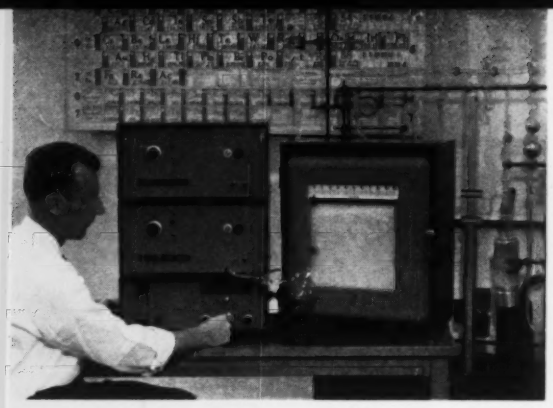

FIG. 1. ROUTINE VAPOR PHASE chromatography analysis in a research laboratory using the elution method. The instrument consists of a control module (bottom) and one or more analyzer modules (in work pictured here, 2 analyzer modules are used).

Vapor-Phase Chromatography

Vapor-phase chromatography provides fast, simple, accurate, and low-cost analysis of almost any mixture. Although it is flexible in choice of operating parameters, can separate closely related materials, and can use micro-samples, it has limitations.

A. P. GIFFORD

Consolidated Electrodynamics Corp.

CHROMATOGRAPHY denotes the separation of the components of a mixture by selective adsorption. Originally it was an analytical method used to separate colored plant pigments. The mixed pigments were added to the top of a tube filled with calcium-carbonate granules and were washed through the tube with a suitable solvent. Each pigment moved through the column at a different rate, depending on its affinity for the adsorbent. The mixture was thus separated into colored bands whose heights were proportional to the quantity of each pigment in the original sample.

The same general technique is used in other chromatographic procedures, including liquid chromatography, paper chromatography, and vapor-phase chromatography (VPC). In the latter procedure the mixture to be analyzed passes through the tube (or column) in the vapor state (Fig. 1), and is of the greatest interest.

Chromatographic methods

The heart of the process, the chromatograph column may be a tube of glass, stainless steel, or copper. Column lengths vary from 4′ to 30′ and diameters from ¼″ to 1½″. Some analysts prefer straight or U-shaped columns, others prefer helically coiled shapes for compactness.

Two general mechanisms are in use for separation of the components in a vapor-phase chromatographic column: (A) differential adsorption and (b) differential solution (or "partition").

Vapor Phase Chromatography

Adsorption columns commonly use activated forms of charcoal, alumina, or silica gel. *Partition* columns use an inert solid, such as Celite, impregnated with a non-volatile liquid, such as mineral oil, nitrobenzene, tricresyl phosphate, and dibutylphthalate.

Fixed gases, such as hydrogen, carbon monoxide, and methane, are best resolved in adsorption columns. The gases from propane on up in molecular weight can be handled easily in partition columns. The apparatus and techniques are similar for the two methods.

As the separated gases emerge from the chromatograph column (Fig. 2), any property that distinguishes them from the carrier gas can be used to detect the amount of each gas present; thermal conductivity is simple and the most widely used. (In choosing the optimum detector for a particular application, consideration is given to the properties of the carrier gas and the gases to be detected as well as to the sensitivity and linearity required by the application.)

Thermal-conductivity cells usually consist of two temperature-sensitive resistance elements connected in a bridge circuit. One element is located in the path of the eluent stream (carrier plus separated gases) from the chromatography column; the other is in the path of the carrier alone to provide a reference level.

Among the general analytical techniques which can be used with either an adsorption or a partition column are: (a) elution, and (b) displacement.

Elution analysis involves the addition of the sample to the top of the column and "washing" it through the column with a continuous flow of carrier gas. If the gas flow rate is held constant, components can be identified by their retention *time*. One characteristic of

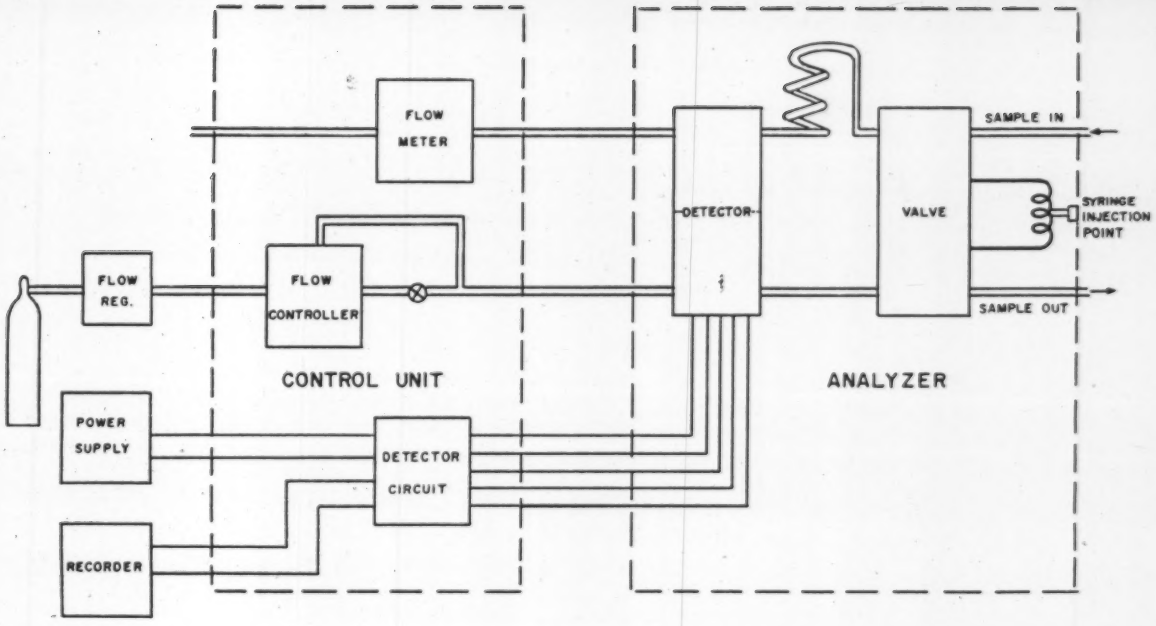

FIG. 2. SCHEMATIC OF TYPE 26-201 chromatograph. Detector picks up variations in thermal conductivity. Recorder plots this against time to show separation of components in helical adsorption column.

this method is that separations are clean and the recorded peaks are generally resolved completely. Quantitative results are computed by measuring the area under each peak, which is proportional to the quantity of component present. The carrier gases commonly used in elution chromatography are nitrogen, helium, and hydrogen.

In the displacement method a carrier gas is not used; the sample components are displaced from the adsorbent by introducing a component that is more highly sorbed than any of the sample components. Each component tends to issue from the column in the pure state and can be collected and identified.

Separations are imperfect in the displacement method because each component follows "on the heels" of the previous one creating intermediate mixed fractions between them. This makes estimation of the separation point difficult.

Advantages and Limitations

Vapor-phase chromatograph is not quite as fast as mass spectometry and one can't easily take a "quick look" at a single component in a sample. VPC is not as easily adaptable to all types of samples as the mass spectrometers; it takes a selected set of operating parameters and equipment set-up to obtain optimum results. This throws the balance toward the mass spectrometer when one instrument must handle a variety of chores. VPC is simple to operate and it provides very creditable accuracies for many routine analyses of gases and volatile liquids in control laboratories.

Another limitation of VPC is that it is basically quantitative rather than qualitative; all components must be known or expected because the only means of identification is the emergence time from the column. Thus the mass spectrometer has a big edge for exploratory analyses in most cases. However, the combination of VPC and mass spectrometry makes a powerful exploratory tool as VPC can separate a sample into narrow fractions for subsequent examination by the mass spectrometer.

Process monitoring

Considerable interest has been shown in vapor-phase chromatography for process monitoring. Fig. 3 shows a typical instrument for the elution method that will handle a wide variety of compounds, including liquids with boiling points up to 325°C.

The instrument does not monitor continuously because the nature of the technique is a "batch" method —sampling is done intermittently. "Slugs" of material to be analyzed are taken from a stream and admitted into the instrument by automatic valving.

The instrument comprises (1) the analyzer, designed for use at the sample point in the plant or other similar hazardous location, and (2) the control unit, which can be 500′ away.

The analyzer includes the chromatograph column, the detector, sampling valve, and the flow control system for the carrier gas. Thermostat control enables precise control of flow.

The excellent reproducibility of the instrument is due to the precise regulation of operating parameters. The sampling valve introduces sample volumes reproducible to better than ±0.5%. Sample temperature and column temperature are controlled to ±0.5°C. Carrier-gas flow-rate variations are held to ±0.1%. Voltage to the thermal conductivity cell is regulated to better than ±0.05%.

Any standard 0-10-millivolt full-scale recording potentiometer with pen speed of one second or faster is suggested for use with the process chromatograph, but higher-sensitivity recorders also can be used under suitable conditions.

This technique for determining natural frequency is powerful. Unlike the step-function or sinusoidal forcing method it does not require knowledge of damping.

MEASUREMENT OF NATURAL FREQUENCY

ALVIN B. KAUFMAN

Arnoux Corporation

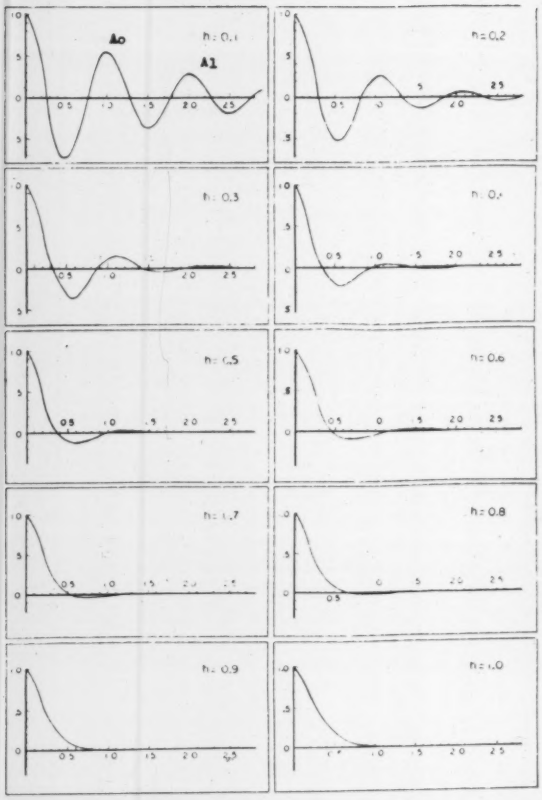

FIG. 1. TYPICAL DECAY WAVE train of a shock-excited mass with various degrees of damping.

METHODS for the determination of natural frequency (f_n) and degree of damping (h) in structures, accelerometers, and other electrical elements where the damping factor h is *less* than 0.6 can be found in the literature[1]. These methods are based on measurement of the amplitude or number of oscillations that follow the application of a step or sinusoidal forcing function.

However, determination of natural frequency where h is *greater* than 0.6 cannot be made by the application of a step or sinusoidal forcing function because in the first instance (step input) an insufficient wave train exists to measure even one-half cycle of oscillation accurately, and in the latter case (sinusoidal forcing) no resonant peak (f_m) will be found. Thus the determination of natural frequency where $h \geqq 0.6$ requires techniques and procedures not generally known to the instrumentation engineer.

Definitions

Natural frequency (f_n) should be defined clearly and carefully because (1) it is more complex and involved than many other vibration terms, (2) it is related to and confused with the several other terms in common use, such as undamped natural frequency, damped natural frequency, and resonant frequency, and (3) the terminology of many writers is ambiguous, misleading, or even incorrect. It is evident from the literature of the field that clarification of these terms is required.

Natural frequency (f_n) is the frequency at which an object will vibrate at zero damping ($h = 0$). In practice h is rarely zero and the observed frequency of vibration is then the *resonant frequency*—f_r or f_m

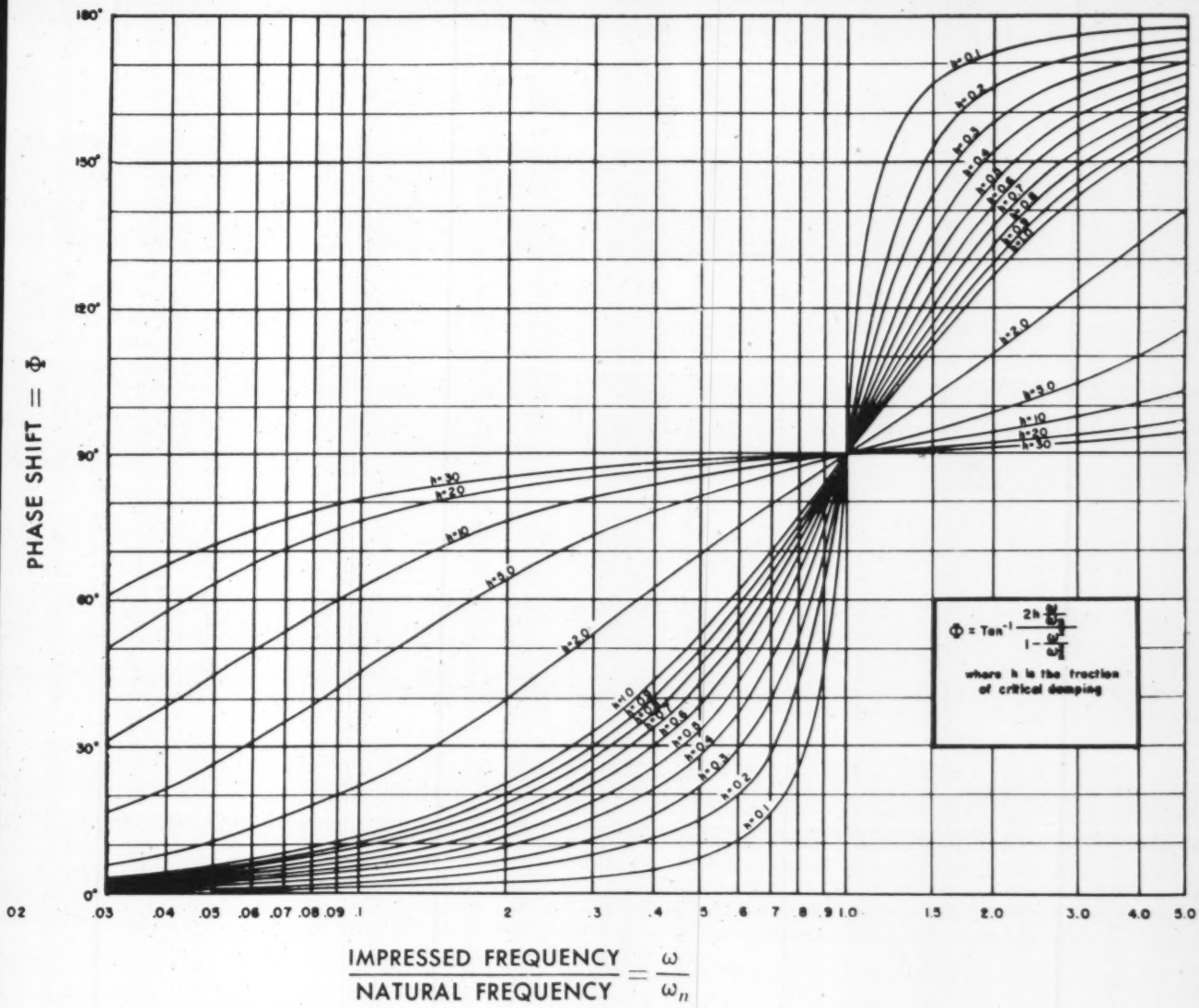

FIG. 2. PHASE SHIFT between a seismic mass and its driving waveform at various degrees of damping.

as the case may be. (Resonant frequency derived from continuous forcing is f_m; that derived from a damped transient is f_r.)

Damping does not affect f_n, but will materially affect the observed f_r or f_m frequency. This can be seen from the classical equation

$$2\pi f_n = \sqrt{K/M}$$

where M is system mass and K its spring restraint. Note that no damping factor appears in the equation; damping has nothing to do with natural frequency and the damping can be varied at will without altering f_n—*provided the real mass of the unit is not altered by the damping*. For example, with viscous (oil) damping in an accelerometer, the pickup moves oil when it is displaced, increasing the effective mass of the unit and lowering its true natural frequency. Here the damping actually changes the effective mass of the unit. Such is not the case with magnetic damping, and it can be said that a change in magnetic damping will not alter the natural frequency.

The technique to be described measures f_n directly, not f_r or f_m. Also, the technique does not produce a "spurious" indication of f_n but, rather, true f_n. With use of other measurement methods where $h \leq 0.6$, care must be taken not to confuse f_m and f_n with f_r[1]. The reader is referred to the references for measurement of f_r, f_m and h.

Determining f_n

The principle of this f_n measurement technique is based on the fact that a driven structure or mass (excepting velocity transducers) regardless of its degree of damping, produces an output signal or maximum deflection that is 90° out of phase with that of the driving force[3,4] when driven at the assembly's natural frequency. This is shown in Fig. 2.

In general the steepness of the input-output phase curves (Fig. 2) at f_n indicates that extreme accuracy of the phase readout device is not critical for accurate f_n measurement, except where $h \geqslant 2$. An oscilloscope or phase meter can be used to locate the frequency

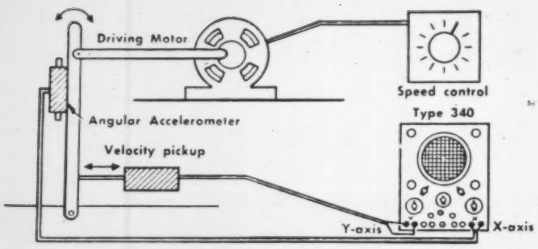

FIG. 3. TYPICAL CRANK-DRIVEN shaker which can be used for f_n determination for angular accelerometer or gyro.

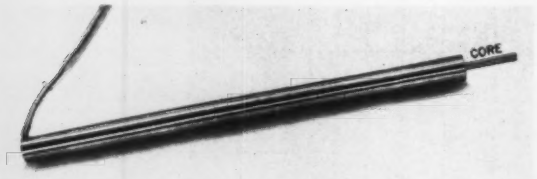

FIG. 4. LVsyn RECTILINEAR VELOCITY PICKUP (Sanborn) used to determine drive-phase relationship.

(f_n) that produces this 90° phase shift between electrical output and mechanical input.

This method of determining f_n can be used for any value of h—not only above 0.6 but even down to $h = 0$. Use of this method where $h \leq 0.6$, however, is arbitrary, depending on equipment available, accuracy desired, etc.

Several methods can be used to secure the mechanical driving force required. The simplest is a crank-driven vibrator, such as is shown in Fig. 3 wherein a low-frequency angular accelerometer is being tested. "Crank" or mechanical vibrators, however, can produce high-frequency harmonics which, if of sufficient amplitude, affect the ease and accuracy of readout. The writer prefers an electrodynamic shaker[5] wherein a linear rather than angular excitation force is employed.

Types of Systems

Almost all systems can be catalogued into two classes—(1) *mass-type* devices such as accelerometers, galvanometers, displacement meters, structures, etc., in which the output signal is proportional to the driving force or displacement, and (2) *velocity* transducers in which the output signal is proportional to the velocity of the unit. The techniques for these two classes are slightly different, as will be explained, but both depend on phase measurements.

Accelerometers

Accelerometer natural frequency is best determined by mounting the accelerometer on an electrodynamic shaker[5]. The motor-generator-driven type is not recommended because of the difficulty of securing a precise frequency[5]. The shaker used for accelerometer f_n determination can be a low-to-medium power unit; these generally employ audio oscillators with power amplifiers for driving the shaker. Integral velocity pickup coils are available in most of these machines. Where not available it is necessary to attach a *rectilinear velocity* pickup (Fig. 4) between the shaker table and platform. (Note that a velocity transducer, as differentiated from a "rod"-driven rectilinear velocity pickup, *is not suitable* because of its change of phase angle vs driving force at various frequencies.)

To determine f_n the frequency of the driving force to the accelerometer under test is varied. The output of the accelerometer is applied to one input of the phase meter and that from the velocity pickup to the other input (Fig. 3). At the natural frequency of the accelerometer its output will be 90° out of phase with maximum shaker displacement, or in phase with velocity. Thus f_n is shown by a zero (0) degree shift on the phase meter.

The accelerometer output also can be applied to the Y axis of an oscilloscope and the velocity signal to the X axis. A resultant zero phase shift indication then determines f_n. This pattern can be complex or simple depending on the relationship of the accelerometer vs velocity-generated frequencies. Note—equal oscilloscope deflections should be secured for each input separately *before* combining to observe for 0° phase, or an erroneous indication may be secured.

It might appear from the procedure outlined above that the velocity pickup could be eliminated and the audio oscillator (drive frequency) wave output be used for the phase reference. Unfortunately this can not be done as a known and constant phase angle between table displacement and drive-frequency waveform does not exist. Table displacement vs drive waveform will exhibit phase variance just as does the accelerometer under test. Hence the necessity for a table-driven velocity pickup coil mounted either integral or external to the shaker.

Phase Measurement

A phase meter with adequate gain on both input channels is probably the best device for the phase measurement. Accurate frequency readout is preferably made with a digital frequency meter such as Berkeley EPUT meter or its equivalent. An oscilloscope, such as the Dumont 340, also can be used as the phase detector; it is essential that the oscilloscope contain X and Y amplifiers which are identical in both phase and amplitude response throughout the range of the frequency spectrum scanned for determination of f_n.

When using the phase meter, identical or zero-phase-shift amplifiers also are required where these are used to bring signal amplitude up to a value suitable for input to the meter. Any phase unbalance between scope internal amplifiers, or between auxiliary external phase meter or scope amplifiers will cause an erroneous indication of the 90° phase-shift point.

Velocity Transducer f_n

Velocity transducer natural frequency is obtained under the same parameters outlined above. An integral shake-table velocity pickup is again used as the reference phase source. As with the accelerometer the seismic mass of the velocity transducer will be forced to its maximum excursion 90° out of phase with the driving force at its natural frequency. (With the accelerometer

this corresponded to maximum signal output.) With the velocity transducer this corresponds to zero signal output (no cutting of lines of force) and, as Fig. 6 indicates, its output will be 90° out of phase with the "driven" linear-velocity pickup.

Other Applications

There are numerous other applications of this technique. Analysis of the device under test to indicate its output phase relationship to driving waveform or displacement, and as referenced to the displacement phase measuring pickup will indicate how it is adapted for other uses, as shown by the following examples.

Gyros with swept potentiometers, or Schaevitz pickoffs, fall in the same class as accelerometers; identical phase-angle relationships exist. The f_n determination is identical, with the addition that d-c excitation must be applied to the swept pot system and its varying output, or the demodulated carrier output of the Schaevitz pickoff must be applied to the phase readout device. The same technique is applied to linear or angular accelerometers and angular or rate gyros; the only difference lies in the application of angular or linear displacement oscillation.

At this point it might be noted that a rectilinear potentiometer, with d-c excitation, could be used to measure shake-table displacement and phase. However, excessive wiper wear and poor resolution would restrict its use. Also, as most shakers have an integral table-driven velocity pickup coil, this approach needlessly complicates the test setup. However, where used, it must be noted that its output is *in phase* with table displacement, whereas the velocity pickup has a 90° phase shift and, therefore, a correction to the f_n phase figure is required.

Galvanometer f_n also can be determined. Here special additional criteria exist: a second galvanometer is used as the phase reference device. Its natural frequency must be at least ten times higher than the galvanometer under test. Its damping must be between zero and 0.3 to holds its phase within a few degrees of zero over the frequency spectrum scanned. The resultant f_n figure is not as accurate as can be secured with other methods[1] where the damping $\leqslant 0.6$.

Structures and shock mounted objects can have their f_n determined in procedures similar to the method used with the accelerometer. A strain gage can be used on the structure (Fig. 7) to determine the phase of maximum load. A linear potentiometer can be used to determine the deflection between the shock mounted object and its base plate. Careful study will show many other alternatives.

References

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2. G. White, "Natural Frequency," Instrument Note #12, Statham Laboratories.

3. Forest K. Harris, *Electrical Measurements*, pages 627, and 628, John Wiley and Sons.

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5. Kaufman & Mitchell, "Shaketable Ratings and Accelerometer Calibration," *Radio-Electronic Engineering*, February, 1955.

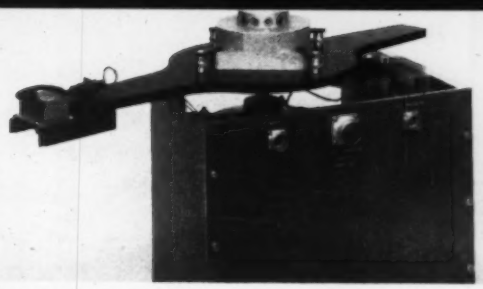


FIG. 5. MODEL AAC-10 ANGULAR ROCKING table (Statham) with angular accelerometer mounted for test. Integral velocity pickup can be seen under table near its right end.

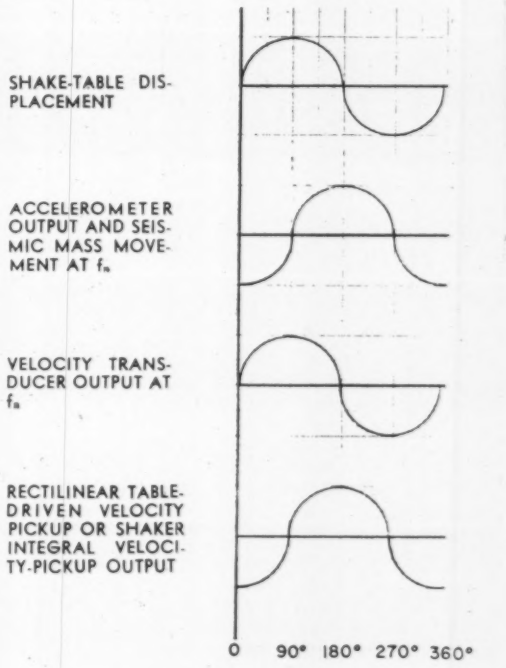


FIG. 6. PHASE RELATIONSHIP of transducer output to driving waveform.

FIG. 7. LINEAR UNBONDED STRAIN gage accelerometer (Statham A5A) installed on MB linear shaker for f_n determination.

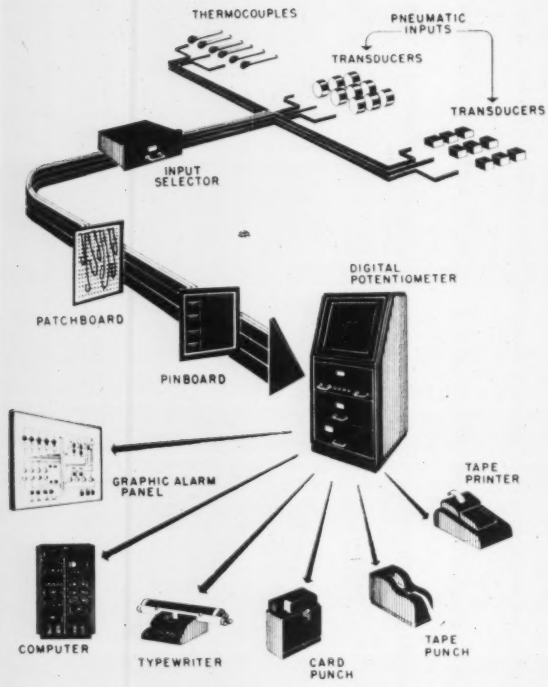


FIG. 1. THE DIGITAL POTENTIOMETER, nerve center of this data handling system, measures and transforms temperature, pressure, flow, viscosity and vibration signals into numbers which are then processed and typed out or punched into tape or cards.

DIGITAL AUTOMATION—NO. 26

This pinboard-programmed digital potentiometer scans many process variables, digitizes the data, and provides digital measurements accurate to 0.1% at a rate of one reading per second.

New Data-Handling System uses a

A MODERN DATA HANDLING SYSTEM must collect vast amounts of industrial process information and speedily convert it into language that operators and computers can use. Nerve center of the system shown in Fig. 1 is an advanced type of measuring device known as a digital potentiometer.

The digital potentiometer (Fig. 2) measures an unknown variable voltage signal by comparing it to "known voltages"—obtained from a voltage dividing circuit in which the output of a regulated power supply is impressed across a number of series-connected resistors. To select "known voltages" the potentiometer actually transfers precision fixed resistors from one leg of the voltage-dividing circuit to the other. The transfer operation is analogous to a sliding contactor moving across a variable resistor.

To measure an unknown voltage the digital potentiometer first actuates the relay shunting the largest resistors in the voltage-dividing circuit. This transfers this resistance into the output leg, providing a proportional millivolt signal. The amplifier compares this signal to the input variable and decides whether to retain or reject this millivoltage (i.e., this relay position).

When a "known voltage" is less than the unknown signal this voltage is retained. Then the next lower incremental voltage is added to the previously retained voltage and their sum is compared to the unknown voltage. If the sum exceeds the unknown voltage, the *incremental* voltage only is rejected and the next lower incremental voltage is selected and added to the original retained voltage. This totaled voltage is compared, in turn, to the unknown voltage.

When this procedure has been repeated for the four largest resistors, the resulting contact closures can be interpreted as the first decimal digit of the value of the unknown variable.

The digital potentiometer proceeds in sequence to select and add each lower incremental voltage to any retained voltages. Each time an incremental voltage is added, the total sum of the selected voltages is compared to the unknown variable. The amplifier decides, at each step, whether the incremental voltage is to be retained or rejected. The high-gain precision amplifier used is chopper stabilized and has a long-term drift of only 2 microvolts. Negative feedback is used extensively in its design, making the amplifier insensitive to tube parameters.

The comparison "known voltages" are connected into the measuring circuit by means of relays so the

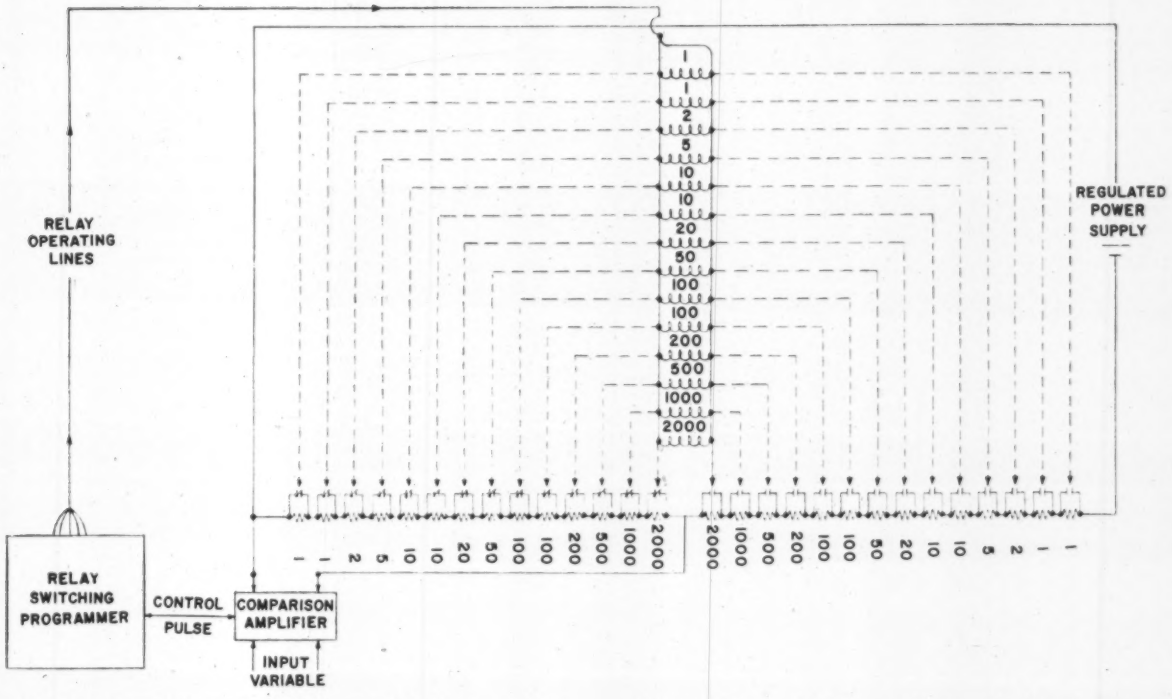


FIG. 2. RELAY SWITCHING CIRCUITS shunt the resistors in the voltage-dividing circuits in sequence in order to compare the known voltage with the unknown signal.

Digital Potentiometer

SAUL MEYER
MARVIN BLYNN

Minneapolis-Honeywell Regulator Co.

value of the unknown variable can be expressed in digital form merely by interpreting the pattern of the relays. This information is made available as a contact closure pattern by adding an extra contact to each selector relay.

One complete cycle of operation (including printout on a typewriter) takes place in less than one second.

Digital Potentiometer Circuits

All resistors are permanently series connected in the voltage-dividing circuit. Instead of a single resistor for each value, the resistors are paired. To shift a given increment of resistance from one leg of the circuit to the other, relay contacts merely shunt one resistor and open the shunt to its paired resistor in the other leg.

The shunting contacts for a given pair of resistors are on the same relay. One contact is normally open, while the other is normally closed. Actuating a single relay thus transfers a selected resistance value from one leg of the voltage divider to the other. This keeps a constant load on the power supply, which has stability better than 0.01%.

Mercury-wetted relays are used to switch the resistors in the measuring circuit. A group has been in continuous operation over two years—four billion operations—without failure.

The magnetic sequencing switch, which programs the mercury-wetted relays to obtain the proper combination of measuring-circuit resistors, has no sliding contacts. The contacts are hermetically sealed for maximum reliability and minimum maintenance. Life tests represent many years of continuous operation.

Measuring-circuit resistors are accurate to 0.01%.

While the system requires four pairs of resistors for a single digit, increased measuring resolution can be obtained by adding additional resistors. Resistors must be added in pairs with one in each leg of the dividing circuit. Sizing the resistors ten times as large (or 1/10 as large) as the existing resistors provides a decimal relation between each group of four pairs of resistors.

Each digital potentiometer provides digital indication in a binary code. Each of the measuring circuit relays is wired to a neon bulb that glows when the relay operates. These bulbs are arranged on the front panel in a 5-2-1-1 code; each vertical column of 4 bulbs represents 1 digit. It is only necessary to add the numbers represented by the lights to get a reading, as shown in Fig. 4.

Accuracy

The accuracy is expressed in terms of percent of reading. The accuracy is ± 0.1% of reading or ± 1 digit, whichever is larger.

In order to use this accuracy the numerical printout has been extended to provide four significant digits for numbers from 100 to 400. For example, the number 200, if expressed in three significant digits, would have a digital solution of no more than ± 1 digit. This is one part in 200 and is no better than ± ½ of 1%. The digital potentiometer, by printing four significant digits (200.0), allows a digital resolution of 1 part in 2000 or ± 0.05%.

The system sensitivity is 10 microvolts per digit for full accuracy. Greater sensitivity can be provided at reduced accuracy. The minimum full-scale input signal for a total 4000-digit output is 40 millivolts. For a total 1000-digit output, the minimum signal would be 10 millivolts.

Pinboards

The pinboards overcome a major limitation of many data-handling systems. Such systems had the functions of range and measuring-circuit selection built into individual positions on the input selectors, thus preventing changing the types of inputs or their ranges. It also established a rigid format for the log sheet.

With the new pinboard (Fig. 5) the operator may substitute one type of input variable for another merely by changing the location of a few pins. Thermocouple inputs can be substituted for linear millivolt inputs, or vice versa. Digital spans, zeros, and alarm points can be changed as necessary to accommodate changes in primary measuring instruments or transducers.

The simplicity of setting scale-factor adjustments on millivolt inputs merely by pinning the full-scale value of the variable on a digital pinboard provides these advantages:

1. It requires no mathematical calculation.
2. As the variable does not have to be indicated while the scale factor is being set, it can be done while the system is in operation.
3. Precision resistors permit high accuracy and resolution in setting the scale factors.

Flexibility

The flexibility of a data-handling system is measured by the ease with which an operator can perform the following functions:

1. Substitute one type of input for another.
2. Rearrange the sequence with which inputs are logged out.
3. Change the range of input variables.

The pinboards provide this flexibility and insure against obsolesence. Within the limits of the number of input variables for which it was designed, such a data handling system can be transferred from process to process.

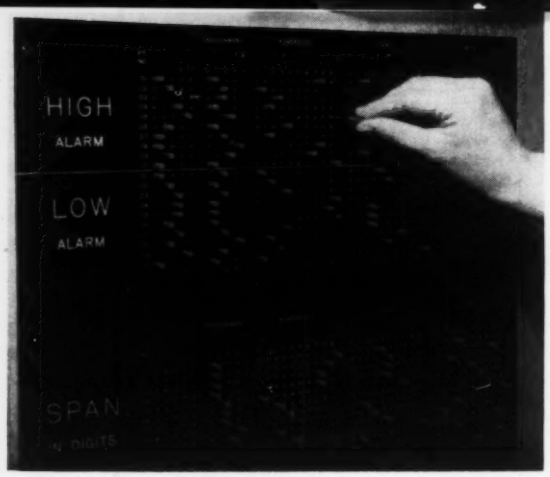


FIG. 3. OPERATOR IS CHANGING high alarm point while system is operating.

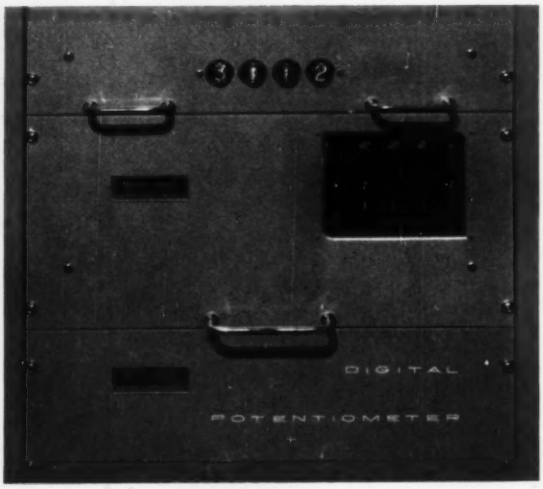


FIG 4. DIGITAL INDICATION is provided in both binary code and in decimal digits.

FIG. 5. THE PINBOARD FUNCTIONS like a telephone switchboard to set up measuring circuits.

ELECTRONIC CIRCUITRY

CHARLES F. KEZER
Digitronics Corp.

MILTON H. ARONSON
Instruments & Automation

The circuit is the heart of all electronics. Here are 2 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

MONOSTABLE MULTIVIBRATOR

The monostable or "one-shot" multivibrator is widely used to define a particular time interval. This circuit differs from the conventional cathode-coupled monostable multivibrator in the coupling method used. Although it has no particular advantage over that type, it can be stabilized (in pulse duration) by the technique shown in the next circuit.

The right-hand half of the 12AT7 tube is normally conducting because its grid is returned to ground and its cathode to −100 v. The plate current through resistor R_1 produces a voltage drop large enough to hold the left-hand triode beyond cutoff. Application of a negative trigger pulse as shown momentarily drives the right-hand triode to cutoff. The plate potential of this tube rises to ground potential as does the grid of the left-hand half, which then conducts. This causes a drop in plate potential of the left-hand half, which is coupled through capacitor C to the grid of the right-hand half, driving it far beyond cutoff in conventional regenerative action.

E_1 is the initial voltage developed on the timing circuit (potential drop on left-hand plate when stage conducts). When this stage is cutoff, the grid begins to charge in a positive direction: the voltage at this point increases exponentially toward ground. Eventually, the rising grid voltage of the right-hand triode will cross the cutoff voltage E_2, bringing this tube back into conduction, and causing a regenerative return to the resting state. After the charge on capacitor C has stabilized, the circuit is ready for another trigger.

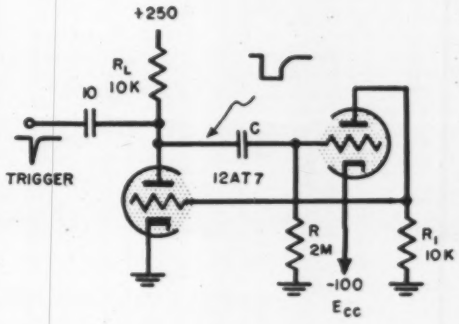
The output pulse, taken from the plate of the right hand triode, is a positive-going pulse of about 30-v amplitude. Duration of this pulse, using the notation above, is determined from

$$t = RC \log_e \left(\frac{E_1 + E_{cc}}{E_2 + E_{cc}} \right)$$

From this equation it may be seen that the time duration of the output pulse is affected by the circuit voltages and tube characteristics, as well as the value of the time constant RC. The initial voltage applied to the timing circuit, E_1, is the major source of time duration change. It is determined by the supply voltage E_{bb} (250 v) and by the current drawn by the tube in the conducting state. It is normal for this current to decrease during the useful life of a tube, resulting in reduction in pulse duration.

Circuit is much less sensitive to changes in voltage E_2, the cutoff voltage of the right-hand triode, as this is normally only 3 volts for the 12AT7 tube, and E_2 forms only a small part of the $E_2 + E_{cc}$ sum in the equation. A 5% increase in voltage E_{cc}, however, will produce a 3% reduction in time duration.

For many purposes, such as television broadcasting, better stability throughout tube life is desired. A unique method of stabilizing the voltage E_1 is shown in the next circuit.



Effect of component and supply-voltage tolerances:

Age V_1 to ½ current	±12.0%
±5% E_{cc}	± 3.0%
±5% E_{bb}	± 1.0%
±1% R and C	± 2.0%
±40% E_2	± 2.0%
Age V_2 to ½ current	no effect
Total	±20%

Input: Negative trigger, at least 5-v amplitude, and of duration much shorter than output pulse.

Output: Positive-going pulse, 30-v amplitude, duration depends on value of C; C = 0.66 uuf per usec.

Power supply: 6.3 v ac to 0.3 amp; −100 v dc at 3 ma quiescent; +250 v dc at 0 ma quiescent, 12 ma during pulse.

Source: Arch C. Luther, Jr., Engineering Products Division, RCA, Camden, N. J.; also *RCA Review*, September, 1955.

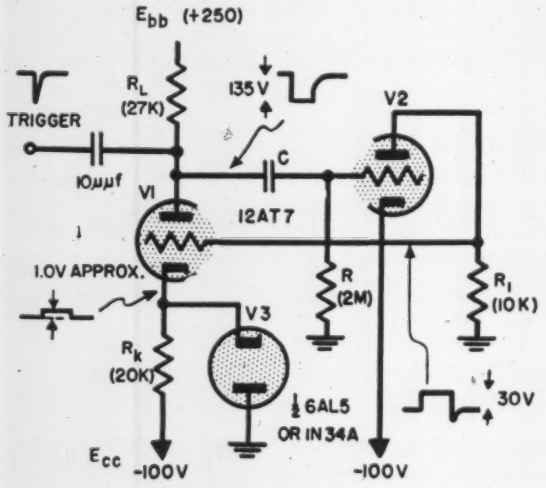
STABILIZED MONOSTABLE MULTIVIBRATOR

Greatly improved stability over the preceding circuit is obtained by the addition of the stabilizing resistor R_k (20 K) and diode V3. Theory of operation is sufficiently well developed that it is relatively easy to calculate pulse width to within about 1% for circuits operating from seconds to microseconds.

Operation of the circuit is essentially the same as that of the preceding one except that the cathode resistor R_k prevents the left-hand triode V1 from going to zero bias. During the pulse interval, when V1 is made conducting, its grid voltage with respect to ground will be exactly zero, because V2 is cut off and there is no current through its plate resistor R_1. The operating point of V1 during this interval has been established by proper choice of R_k and R_L to cause the cathode of V1 to run slightly positive due to cathode-follower action, causing a net grid-to-cathode bias. This causes diode V3 to be cut off, so that all of the current in V1 must flow through R_k to the negative supply voltage. Thus the drop across the cathode resistor R_k when V1 is conducting must always be equal to

100 volts plus the small positive cathode bias required. Since the only part of this drop (across R_k) that is a function of tube characteristics is the relatively small bias portion, the plate current is effectively stabilized against variation in tube characteristics. Consequently the initial voltage on the timing circuit, E_1, which is fixed by the plate current, is also stabilized.

With a high-mu tube, such as the 12AT7 shown, it is readily possible to stabilize E_1 to well within 1% for a wide range of tube characteristics and aging to half-current.



When the multivibrator is in its resting state, V2 conducts to hold V1 beyond cutoff. The diode V3 is necessary to make this possible, and it will conduct to hold the cathode of V1 at ground so that a small drop across resistor R_1 is sufficient to cut off V1.

Production experience with similar circuits used as frequency dividers in television synchronizing generators has shown that they can be mass produced, using 1% components, with delay tolerance not exceeding 5%.

Pulse duration may be computed from

$$t = RC \log_e \frac{(e_c + E_{cc})(R_L/R_k) + E_{cc}}{(E_{cc}/\mu_2) + E_{cc}}$$

where e_c is the grid-to-cathode voltage of V1 while conducting, and μ_2 is the amplification factor of V2 at the cutoff point.

Other symbols are as shown on the diagram.

Effect of component and supply voltage tolerances:

Age V1 to ½ current	−0.7%
±5% E_{cc}	±0.04%
±5% E_{bb}	±0.2%
±1% R and C	±2.0%
±1% R_L and R_k	±1.4%
±40% $1/\mu_2$	±1.2%
Age V_2 to ½ current	no effect
Total	−5.5, + 4.8%

Input: Same as preceding circuit.

Output: Positive-going pulse, 30-v amplitude, duration determined by C; C = 0.596 uuf per usec.

Power supply: 6.3 v ac at 0.3 amp; −100 v dc at 8 ma quiescent, 5 ma during pulse; 250 v dc at 0 ma quiescent, 5 ma during pulse.

Source: Arch C. Luther, Jr., Engineering Products Divison, RCA, Camden, N. J.; also *RCA Review*, September, 1955.

NOMOGRAM FOR SECOND ORDER SYSTEMS

Third of a series of quickie tools—potent time savers for rapid approximations of system behavior.

LESLIE R. AXLEROD
Cook Electric Co.

THE SOLUTION of a second-order linear differential equation with constant coefficients can be characterized by various pairs of constants. One convenient pair comprises the damping ratio (ζ) and the undamped natural angular velocity (ω_n). Consider the following second-order equation:

$$F(s) = A_2 s^2 + A_1 s + A_0 \qquad (1)$$

In a servo system, A_2 can be the mass of the system, A_1 can be viscous damping coefficient, and A_0 can be the spring rate associated with that system.

If the constants are defined as:

$$\omega_n = \sqrt{A_0/A_2} \qquad (2)$$

$$\zeta = \frac{A_1}{2\sqrt{A_0 A_2}} \qquad (3)$$

then it is possible to write:

$$s^2 + \frac{A_1}{A_2} s + \frac{A_0}{A_2} = s^2 + 2\zeta\omega_n s + \omega_n^2 \qquad (4)$$

The family of straight lines in Fig. 1 portrays ζ and ω_n as functions of A_1/A_2 and A_0/A_2. These two examples illustrate the use of Fig. 1:

EXAMPLE 1:

Given $F(s) = 0.01s^2 + 4.2s + 900$. Find ζ and ω_n. The broken line in Fig. 1 shows the sequence of steps used in finding $\zeta = 0.7$ and $\omega_n = 300$ rad/sec.

EXAMPLE 2:

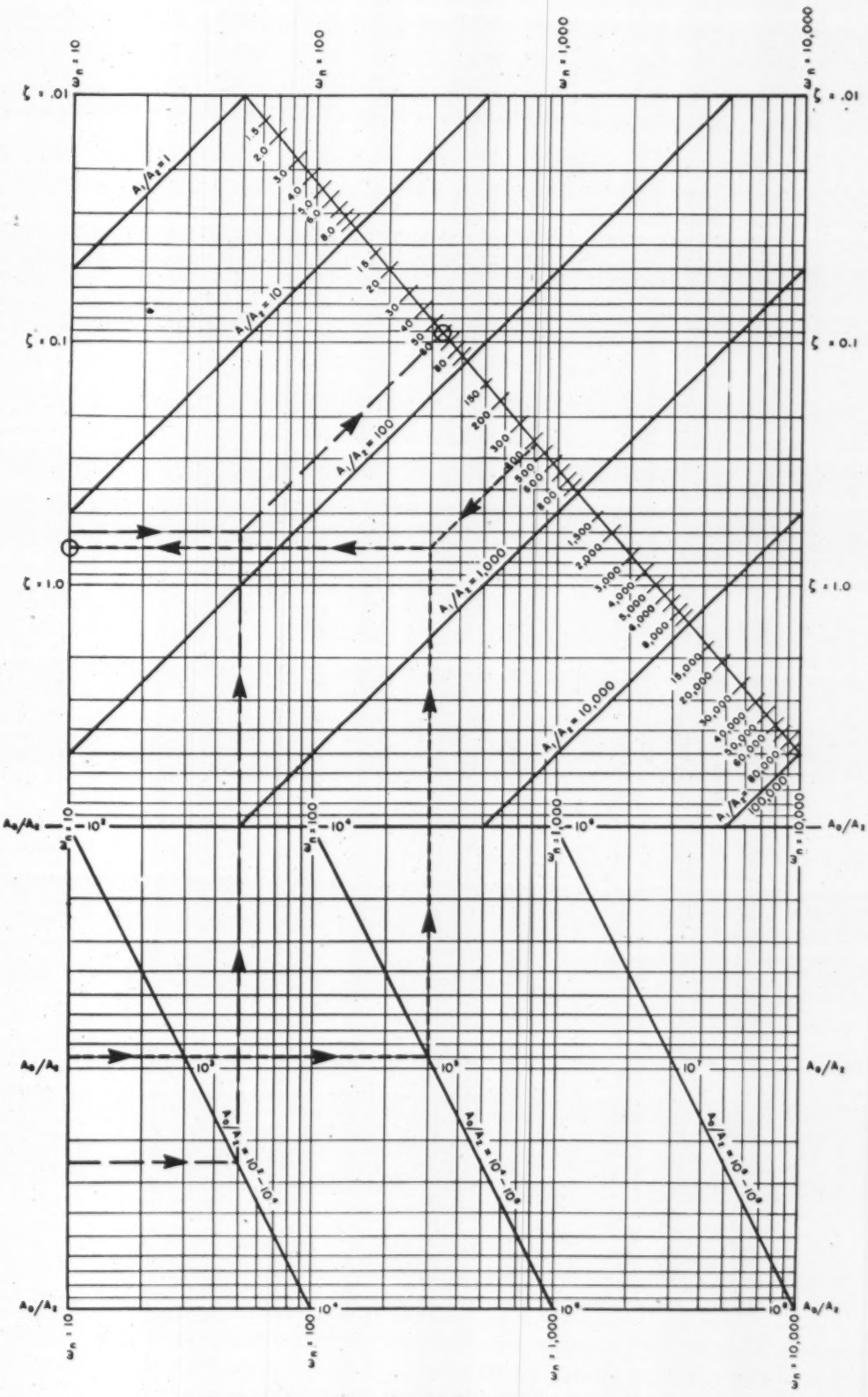
Given a system consisting of a 0.4 slug mass suspended from a spring with a spring rate of 1000 lb/ft. How much viscous damping is needed to obtain a ζ of 0.6? The dashed line in Fig. 1 shows the steps used in finding that $A_1 = 60A_2 = 24$ lb-sec/ft.

CORRECTION: In Mr. Axelrod's article last month, equation (1) should have read

$$\omega_{tr}/\omega_n = \sqrt{1 - \zeta^2}$$

and equation (2) should have read

$$\omega_r/\omega_n = \sqrt{1 - 2\zeta^2}$$



ζ AND ω_n AS FUNCTIONS OF A_0, A_1, A_2

$$\left[A_1/A_2 = 2\zeta\omega_n \qquad A_0/A_2 = \omega_n^2 \right]$$

Journal of the S C M A . . .

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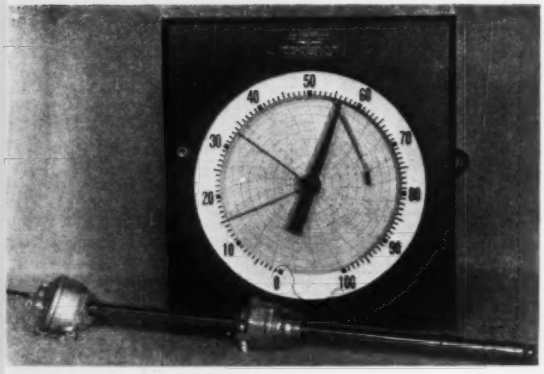

FIG. 1. SELF-BALANCING recorder and velocity probe.

Metering Gas with a

This gas flow indicator, based on the heated thermopile, is safe for explosive atmospheres.

RAYMOND T. DOYLE
Hastings-Raydist, Inc.

THE HEATED-THERMOPILE principle has found wide application in the measurement of velocity, flow, pressure and vacuum, yet its acceptance in measurement of gas flow has not been as rapid as in other applications due to the natural reluctance to use instruments which could conceivably cause ignition from a spark or from the temperature of the heated elements in the presence of explosive gas mixtures. However, the heated-thermopile principle allows a number of couples to operate at very low temperature rises, and present designs of these instruments (Fig. 1) make them safe. These couples now can operate normally at temperature rises less than the ambient temperature difference normally incurred between summer and winter weather (31C° temperature rise).

Principle of Operation

The vacuum, velocity, and flow measuring instruments based on this patented* heated-thermopile principle use a low voltage a-c bridge circuit (Fig. 2). The sensing elements (A and B) are noble-metal thermocouples which are attached to studs to establish a thermopile which becomes part of a bridge circuit. The thermocouples are heated by alternating current. A change in flow or vacuum causes a change in temperature of the thermocouples, resulting in d-c output of the thermocouples.

A third thermocouple (C) is included in the d-c meter circuit. This couple is unheated and is the same size as those in the a-c circuit. A sudden or momentary change in ambient temperature develops thermoelectric voltages in all the thermocouples, but the transient effects in heated and unheated elements are arranged to be equal and opposite, so the unheated couple compensates for these transient effects of change in ambient temperature.

The basic circuit (Fig. 2) is powered by a 110-volt, 60-cycle, a-c source, stepped down by transformer T-1. The entire thermopile (within the circle) can be built into an air velocity probe, a vacuum gage tube, or a flow tube, and installed directly into a line or across an orifice. Indicator M-1, which measures

*U. S. Patents Nos. 2,540,822; 2,652,723; and 2,745,283. Hastings-Raydist, Inc.

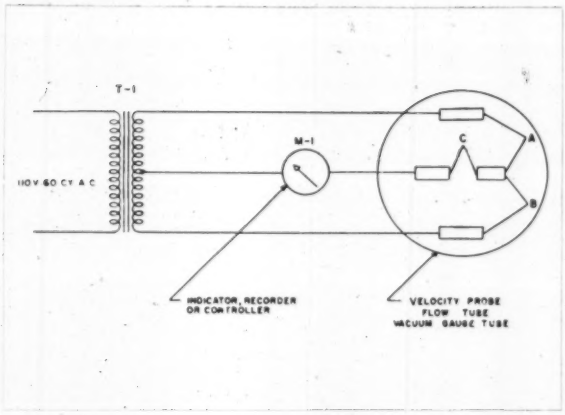

FIG. 2. BASIC CIRCUIT of the heated thermopile flowmeter.

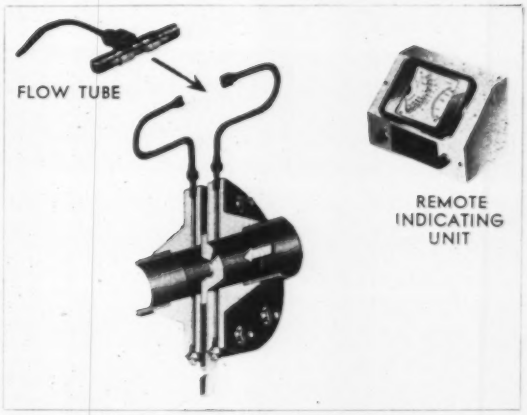

FIG. 3. THERMOPILE FLOW TUBE installed for measuring flow by diverting part of the flow around an orifice in the stream.

Heated Thermopile

the d-c output in millivolts, can be an indicating meter or a circular or strip chart recorder, or it can be used to operate a controller or alarm device.

The thermopile illustrated in Fig. 2 is the simplest form. Additional thermopiles can be used for applications requiring larger output or lower operating temperature differences.

The instrument operates with maximum power to the couples of only a fraction of a watt (0.1 watt normally; 0.2 watt maximum); a maximum voltage of less than 1 volt (normally 0.43 volt), and a maximum current of only a fraction of an ampere (normally 0.23 ampere). This low energy is insufficient to cause a spark even if the couples should fail. The temperature rise of the couples is so small as to be of negligible importance, and the electrical circuitry has been designed so that failure of any two components still presents no hazard.

The circuitry was designed so that an open circuit or a short circuit of any resistor would result in no dangerously high temperatures.

Tests have been made with a number of gases including hydrocarbon gases, which have the lowest point of ignition. Thermocouples failures have been simulated and possible failures of the instrument have been created intentionally. Voltages of 240 volts have been applied to instruments designed for 115-volt operation without producing any appreciable temperature rise on the thermopile. Both from a theoretical and a test viewpoint, the instrument has been found to be safe. The instrument is said to meet the standards for use where explosive vapors may be present, as specified under Class I, Group D, of the National Electric Code, and models of the indicator power supply and probe are being submitted to Underwriters Laboratories, requesting their approval for use in the presence of explosive gases and gas and air mixtures.

Mass Flow

An important feature is that measurements are almost perfectly indicative of *mass* flow. Most flow instruments measure a *volume* of gas, and the total quantity of gas then depends on temperature and pressure. However, many processes are dependent on the total quantity or the pounds of gas flowing, and a *mass flowmeter* should be used so that errors are not introduced by changes in temperatures or pressures. Pitot static and orifice-type instruments give indications proportional to the density times velocity squared. The resulting measurements are neither of volume nor of mass if the temperatures and pressures vary and, therefore, corrections for temperature or pressure changes are necessary to prevent errors. The thermopile instrument is a mass flowmeter so long as $\sqrt{KS\rho}$ is a constant, where K is the thermal conductivity, S is the specific heat at constant volume, and ρ is the density. Fortunately, the $\sqrt{KS\rho}$ in most gases is a constant over wide ranges of temperatures and pressures. Thus the instrument can be calibrated directly in terms of pounds of gas per hour passing the thermopile.

Adaptation of the heated-thermopile circuit to gas flowmeters has been accomplished by inserting the thermopile in a flow tube. The flow tube can be inserted directly in the line, or used to measure a fraction of the total flow as illustrated in Fig. 3. Using the same flow-tube instrument for differential

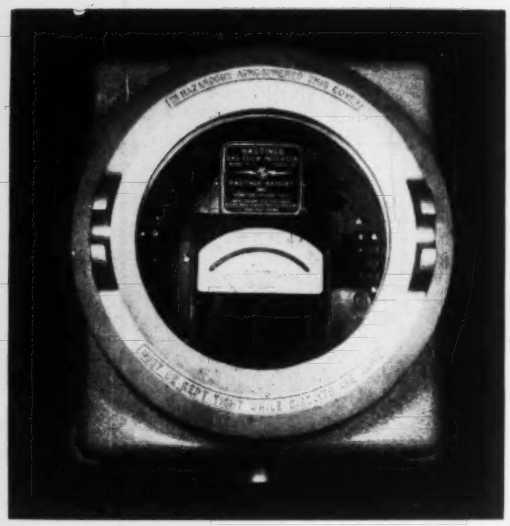

FIG. 4. GAS FLOW INDICATOR mounted in explosion-proof housing.

pressure measurements, the normal range is 0.001" to 2" H_2O.

Applications

The thermopile output can be used to measure any variable of a gas or mixture of gases which has an effect on the thermopile temperature differential. The introduction of a gas which has a thermal conductivity different from that of air will affect this temperature differential. Flow of gas past the thermopile will cool the heated couples and thus reduce the temperature differential in the thermopile. The resultant change in voltage output of the thermopile can therefore be calibrated in terms of velocity, pressure differential, or mass flow. Many models will measure accurately and furnish good readability for velocities as low as 5 fpm. Other models will measure velocities up to 400 mph.

The pressure of the gas also has an effect on thermal conductivity and, therefore, an effect on the temperature differential of the thermopiles. While the thermal conductivity of gases at atmospheric pressure changes little with changes in pressure, in vacuum systems thermal conductivity changes rapidly with pressure. The temperature differential can therefore be calibrated to measure vacuum and low pressures. Vacuum-gage models cover the absolute pressure range of from 0 to 20,000 microns of mercury. This same principle also can be used to measure indirectly any other qualities which affect the thermal conductivity or rate of flow of the gas past the thermopile.

Changes in the temperature differential of the thermopile produce approximately a logarithmic type of output to the meter or other measuring device. This logarithmic output provides excellent sensitivity and readability for the very low velocities and minute pressure changes. Multi-ranges or increased sensitivity at other points can be obtained by increasing the current to the thermopile.

Special Refinery Designs

Interest was expressed by several refineries with regard to the possible use of this circuitry for measuring the flow of various gases in the hydrocarbon lateral lines and also in the flare stack. (The flare stack has the primary function of disposing of gases released to the stack for safety reasons.) The refineries wanted to know the amount of gas being discharged for safety reasons, but also wanted some method of knowing when gas was lost due to "human error" when personnel failed to close valves or did not completely close off a line.

It was necessary to design a new type of probe to fulfill the mechanical and safety requirements in an installation of this type. This probe is shown with a recorder unit in Fig. 1.

Probes installed in the presence of clean gases will experience an average operating period of two or more months without attention, at which time they can be cleaned by swishing the head of the probe in a suitable solution, such as acetone. Difficulty has been experienced when the probes are used in the presence of sour gases, especially when hydrogen sulfide is present.

It was felt that the operating temperature of the thermopile could be lowered even further, thus increasing the factor of safety for use with explosive gas mixtures. Subsequent modifications were made with a group of the thermopiles in series which, when used in a 2½-millivolt circuit, reduce the maximum rise on the thermocouples to 31 C° above ambient temperature. This was immediately approved for use in flare-stack installations with lateral line use held in abeyance pending further safety tests. An installation in an explosion-proof housing is shown in Fig. 4.

Calibration data have been prepared for air, butane, propane and other hydrocarbons.

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How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

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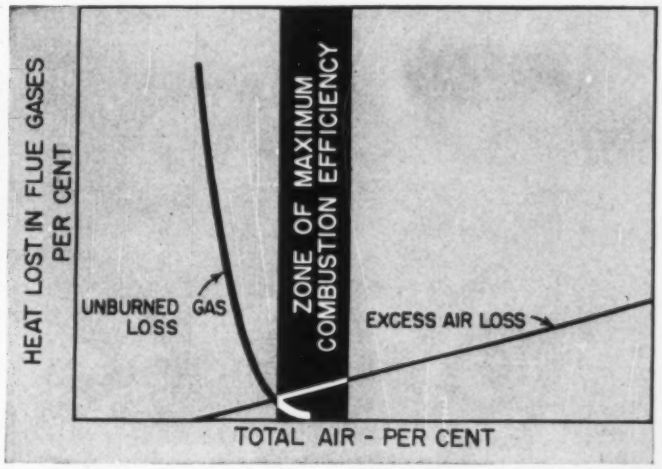
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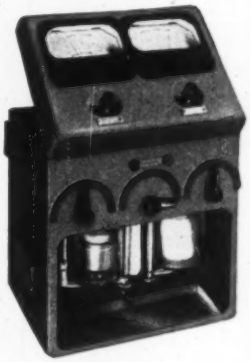

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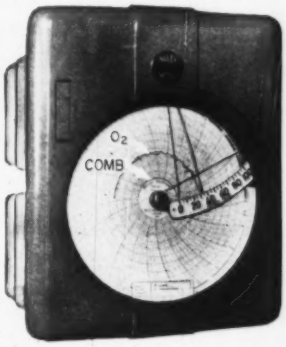

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

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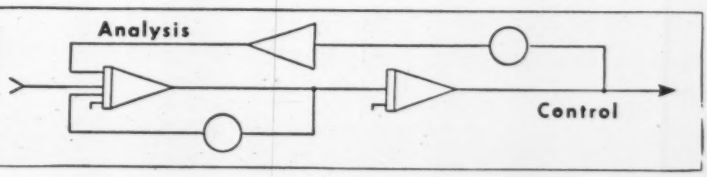

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Bits

For the greater part of Pieces this month we again drew on Hideo Mori's excellent notes on the Eastern Simulation Council meeting at Rensselaer Polytechnic Institute. We also have some abstracts from a Central Simulation Council meeting at Boeing, Wichita, and various other comments under "Info," "He went That-away," and "Thots" which may or may not be worth your reading further after finishing Pieces.

Pieces

EASTERN S/C MEETING OF 15 JULY ON DDA'S

About 50 members representing 30 different groups met on 15 July 1957 at Rensselaer Polytechnic Institute, Troy, New York, to discuss Digital Differential Analyzers.

Bernie Loveman (Reeves Instrument Co., New York, N. Y.) presided in the absence of *Ro Favreau* (Princeton Computation Center, Electronic Associates, Princeton, N. J.) who (the lucky dog) was opening EAI's computation center in Belgium.

Bosworth on Litton DDA

The first speaker of the technical session, *Mr. Bosworth* (Litton Industries, Beverly Hills, Calif.) described the Litton Digital Differential Analyzer. After a few general remarks about DDA's and their place in simulation, Mr. Bosworth pointed out the essential difference between analog computers and digital differential analyzers—in an analog computer the signal is a voltage which varies as a function of time, whereas in the DDA information is contained in pulse trains. For example, assume a pulse train of possibly eight positions and assign a value to each of these eight positions in time. The presence of a pulse in the first position will indicate the presence of 2^0, or 1. The presence of a pulse in the second position will indicate 2^1 or 2, third place 2^2 or 4, etc. The pulse train will then be a binary representation of the number. The important thing about representing numbers in this form is that only two stable states occur: either we have a pulse in a certain position or we don't. The actual pulse can be generated at 200 volts and clipped so that there is a tremendous margin of safety. This is one of the reasons for the power of the digital computer.

DDA *summation* is accomplished by adding pulse trains, whereas analog summation uses resistive networks and a high-gain amplifier. For integrations the digital system has some advantage over the analog. The analog integrates by using an input resistor and a feedback capacitor around a high-gain amplifier. There is, therefore, the possibility of error in the value of the R-C time constant, which must be adjusted. As this may vary with time, temperature, and other effects, the integration will never be perfect. Other effects, such as drift in the amplifier, will appear as spurious inputs and be integrated. The larger the scale factor of integration the greater the effect of this error. The only way to improve the situation is to increase stability of the amplifiers and this involves a limit which the present state of the art is approaching.

The DDA uses a somewhat different technique for integration. Let's suppose we are going to integrate ydx. If y is plotted against x and we integrate, we are just taking the area under the curve. The digital ma-

chine will take the value of y for a given increment in x and compute the area of this rectangle. If we make these increments large, the accuracy with which we integrate will suffer since the rectangle may be a poor fit with the curve of y throughout the increment. In the DDA we can make these increments almost as small as we like. We can have, for example, 500,000 increments per unit of x. If x represents one second, we can have 500,000 increments in one second. The more increments the longer our computation will require, which is one of the limitations of the digital differential analyzer: the greater the accuracy the longer the time of solution.

According to Mr. Bosworth's definition, computation involves a solution of one or more mathematical equations, whereas simulation involves the solution of equations plus the addition of some real part of the system under study—a human pilot, or some mechanical element. The analog computer, Mr. Bosworth explained, is used day in and day out for this kind of simulation and is usually satisfactory, but it does have limitations. Where open-loop systems are involved with no feedback to reduce error the accuracy may be unsatisfactory. And it may be unsatisfactory where long periods of computation time are involved.

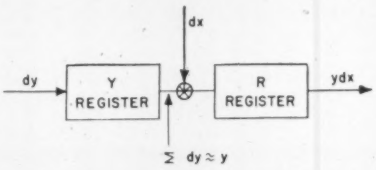
The DDA eliminates the drift problem and performs almost all mathematical operations with greater accuracy. However, to achieve this high accuracy we must have a large number of increments of the independent variable per unit of the independent variable and this limits the speed at which we can perform the necessary operations.

If hardware is to be used in a simulation it becomes necessary to tie it to the digital computer. Considerable work is being done on analog-digital transducers, but no existing commercial DDA is fast enough to handle the large number of small increments necessary for high accuracy while operating in real time. Besides, analog-to-digital and digital-to-analog converters are both expensive and slow.*

At present, to Mr. Bosworth's knowledge, there has been no large-scale use of the digital computer to replace any significant part of a simulation system.* We can say that the DDA, which is one form of digital computer, does have a wide range of usefulness in connection with simulation studies if not immediately as the simulator itself. The DDA can be used to check the setup and solution of an analog computer installation. You can use the analog computer to get a ballpark answer for a system, then a digital computer to pinpoint values in the area of interest. And the digital can be used to establish accurately the stability limits of the system. In an analog computer nonlinearities usually make the solution less accurate; a function generator always has a greater error than a summing amplifier. This is not true with a digital computer, which multiplies variables, introduces arbitrary functions, and generates analytic functions with high accuracy.

Another limitation on the analog computer is that it integrates by charging a capacitor as a function of time, and so can only integrate with respect to time. With the digital computer this isn't so; we can integrate with respect to any independent variable.

The DDA integrators essentially consist of two registers, (actually, locations on the magnetic memory drum) one of which is called the Y register, and the other the R register, as indicated in the figure below.



Increments, dy of a variable y, are introduced into the Y register, which sums them. The output of the Y register, $\Sigma dy \approx y$, will be gated by pulses arriving at a rate dx proportional to some independent variable x, which may be time, or some function of the independent variable. These dx pulses will determine the rate at which the summation in the Y register is added to the R register. Therefore, in effect, we have a product of the summation y and the independent variable dx. This summation, ydx, is an approximation of the integral ydx, i.e., $\Sigma ydx = \int ydt$. $dx \to 0$

As the pulses keep coming into the R register, it fills and overflows at a *rate* proportional to the *integral* of ydx. But the rate, or derivative, of the integral of a variable is the variable itself, so the output of the R register is ydx.

Goldman on Bendix DA-1

The next speaker was *Mr. R. N. Goldman* (Bendix Computer Division, Los Angeles, Calif.), who described the Bendix DA-1 in "A New Approach to the Machine Solution of Differential Equations." The new analyzer, the DA-1, operates with the Bendix G-15D Digital Computer to provide both general-purpose computing and digital differential analyzer capabilities. The DA-1 is a compact unit the size of an office filing cabinet and sells for about $13,000.

Mr. Goldman said that their primary aim in designing the DA-1 was to combine the advantages of other approaches to the machine solution of differential equations in a device of large capacity while avoiding some disadvantages of each, without introducing a set of new ones. A second aim was a reasonable price—one that can be quoted without the sales engineer lowering his voice or the customer flinching!

The strong points of a general-purpose computer are the wide range of problems which may be solved and the great precision of computation. Its most serious disadvantage as a device to solve differential equations is the time and skill required to prepare the problem for the computer. There are many books on numerical analysis which discuss the numerical solution of differential equations by means suitable for machine computation, but the books aren't easy. The programs, being long, are vulnerable to error and extensive machine time is usually required, especially when program checking is taken into account.

The virtue of the electronic analog computer lies not only in the relative ease of programming but in the speed with which the solution can be reached. An analog computer may be able to produce a solution of a set of simultaneous ordinary differential equations describing some physical situation using real time as the independent variable—that is, using the same time scale as the physical process itself. This advantage of the analog computer remains unchallenged.

The DDA is functionally a hybrid; it handles information and performs arithmetic operations digitally, as does the general-purpose digital com-

*Expensive, yes, but slow? Is 5,000 samples per second slow?—Ed.

*See note under Info.—Ed.

puter; but its programming is based on the concept of integrators like an analog computer. And the DDA differs from the analog differential analyzer in other important respects: it does not usually operate in real time; information flow between its integrators consists of a stream of pulses instead of voltage levels; and integrators are operated on serially rather than simultaneously. An integrator's output in a single iteration of operation is either the presence or absence of a pulse. Functions can be generated by forming a feedback loop in which the incremental inputs to a given integrator are the outputs of other integrators.

The DDA, as originally developed, had the accuracy of the general-purpose computer but not its versatility or convenience of input and output. It had the ease of programming of the analog differential analyzer but could not approach its speed.

The DA-1 represents a refinement because:

It provides 108 integrators. In the solution of a differential equation on a digital differential analyzer, one or more integrators are required for each term of the equation. A term which is an "nth" order derivative requires at least "n" integrators. An integrator may also be used as a servo, a decision element, or an adder. By providing more than 100 integrators, problems of complexity involving high-order differential equations, or sets of simultaneous equations, can be solved.

The outputs of all integrators on the DA-1 are available to be used as inputs by all integrators. Interconnection is by numerical coding rather than by patchboard. The coding is decimal, and is entered into the computer from a typewriter keyboard, as are all input and output values.

Initial values of integrals and values of constant multipliers are expressed as positive or negative floating decimal-point numbers. All integrators are processed 34 times per second, and up to seven decimal digits of precision are available. Exponent range is from 10^{-4} to 10^{9}. The computed results are typed out automatically as floating-point decimal numbers at intervals selected by the programmer.

Two of the sources of digital computation error are *roundoff* and *truncation*. Truncation error is due to the nature of the numerical approximation of integration. It can be reduced effectively by reducing the increment size, though the time required for computation will increase. Roundoff error results from the finite length of the arithmetic registers which make up an integrator. It was worse in earlier machines because the dz output of an integrator could possess only one of two values: either $+1$ or -1. A zero output was approximated by alternate $+1$ and -1 outputs. Thus the output of an iteration which should be zero will actually be $+1$ or -1. In certain situations such errors can build up to an appreciable value. If integrators are operated as servos, or as decision elements, the output corresponding to the null position should be zero; if instead it is ± 1, the error will be relatively large whenever the null position is approached. Furthermore, an integrator holding a variable with a slowly changing integral will be unable to indicate those intervals in which the change is zero. To avoid this situation, to reduce computation error, and to increase the speed of computation, incremental transfer between integrators in the DA-1 has been made ternary rather than binary. The output of an integrator may be $+1$, 0, or -1. The size of the roundoff error is reduced because when an integrator is supposed to have a zero output, it has just that.

In addition, because the speed of DDA computation is inversely proportional to the precision desired, and because a ternary transfer machine can obtain the same precision with one less binary digit, the ternary machine works twice as fast.

An outstanding feature of the DA-1 is that since it is an accessory to a general-purpose computer, it can be used in conjunction with the general-purpose computer for the programming of highly involved problems. Empirical function input may be from any of the computer's digital input devices as well as from a graph follower. The DA-1 makes use of a portion of the general-purpose drum memory to hold integrator information, while the remainder of the drum remains available for associated general-purpose computation. The DA-1, therefore, offers for the first time the precision, versatility, and input-output convenience of the general-purpose computer with the capacity and ease of programming—though not the speed—of a fair-sized analog differential analyzer.

Otto on RADC

The next speaker was Lieutenant *Kenneth Otto* (Rome Air Development Center, Rome, New York), who told about his experience with the Bendix D-12 DDA, saying that it has turned out to be an effective computation tool for both research and development projects.

Also at Rome there is an Elecom 120 General-Purpose Digital Computer and a 120-amplifier installation of Reeves analog equipment. Since the DDA combines features of both digital and analog computers, it effectively bridges the gap between the two main operations of the laboratory.

Some characteristics and properties of the Bendix D-12 are:

1. Decimal operation
2. Seven-digit precision
3. Trapezoidal and rectangular integration modes
4. Time reversal (problem can be run backwards in essence)
5. 100 iterations/sec (using 60 integrators); 200 iterations/sec (30 integ)
6. Automatic parameter variation
7. Initial condition reset (automatic and manual)
8. Arbitrary function input
9. Outputs—decimal tabulation or graph plotter
10. Output multipliers (1, 2, and 5)
11. Output sign reversal

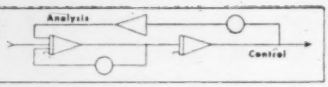
It contains 60 numerical integrators, all of which can be programmed to perform the following analogous functions:

1. Perform a limiting function, like a diode of an analog computer.
2. Perform a switching function, comparable to the use of a relay.
3. Continually correct for an error, like a servo.
4. Multiply a variable by a constant, like a potentiometer.
5. Generate the integral of a variable, with choice of output sign, with respect to time or, unlike an analog, with respect to any other variable.

The last function is, of course, the major one and gives the DDA a big advantage over its analog counterpart in that the integration process is not restricted to time as the independent variable.

Saying that he wanted to describe a few of the basic physical and mathematical characteristics to show fundamentals of DDA operation, to present a few of the many extra features of the Bendix D-12, and to bring out the almost identical method of programming as compared to an analog computer, Lt. Otto launched into a comprehensive description of the operation of their DDA which, though excellent, is beyond the scope* of this *Newsletter*.

*This expression will be recognized by many as one often used to mean "over ye Ed's head." Not so, in this case. The explanation must have been well presented, and it was well written up by Hideo. It is not included here because: (1) It was tutorial in nature; (2) the material is available elsewhere.—Ed.



Many of the problems at Rome lend themselves easily to solution on the general-purpose digital computer while others can be readily solved on the analog. In between these two main problem areas lie the problems which demand too much accuracy for the analog computer, yet cannot be easily adapted to the general-purpose digital: here the Bendix usually finds its best application.

In the digital area they find that problems like the following, which involve integral and differential relationships, can be solved on the Bendix DDA better than on the GP digital computer:

1. Integral equations.
2. Evaluation of integrals resulting from probability and statistical studies.
3. Bessel equations and compilation of tables of Bessel functions.
4. Simultaneous sets of algebraic and differential equations.
5. Boundary value and Fourier integral and series evaluation.

Furthermore, those familiar with numerical methods for solving differential equations agree that they are often laborious and usually need to be tailor-made to fit the individual problem. Often during the analysis of a problem the actual physical system being studied is lost in the shuffle and mathematically a new system is created. Therefore, rather than arriving at the solution by processes analogous to those being studied, the answer is found by some numerical method that bears no relationship at all to the system in question. Lt. Otto has found that the relative ease of mapping and the speed of getting these problems on the Bendix far outweigh the advantages of the digital computer for this kind of work.

In addition to the digital area, they find the DDA even more useful in conjunction with the analog computer. The first, and most obvious, use is for the solution of differential equations when more than three-figure accuracy is desired.

In addition, the DDA is extremely useful as a check on the analog work. Intermediate and final solutions can be checked and, since the DDA has provisions for inserting the exact arbitrary functions into the computer from tape, an easy and exacting check of the effects of approximations used in analog-function generation can be made. Likewise, if one is forced to use mathematical approximations on the analog equipment, it often is possible to run the exact equations on the DDA as a check on the approximate ones.

For example, the Rome analog installation is not large enough to handle curved earth trajectory equations, so they use flat earth relationships. Then they run the curved earth equations on the Bendix to determine the effect of the analog approximations.

The DDA has also been found to be extremely useful in the simulation of sampled-data systems.

Lt. Otto reiterated the advantages of the DDA but cautioned that to achieve analog accuracy the speed must be approximately one-tenth that of the analog, and that for each digit of additional accuracy the solution is slowed by a factor of 10. In other words, a problem taking one minute on the analog would take 10 minutes on the DDA for the same accuracy. To gain two additional decimal digits of accuracy would require about 1000 minutes, or 16 hours. For this reason the present version of the DDA has never replaced the analog computer as the primary method of performing simulation studies.

Hunter on Programming For Analytical Problems

The final speaker was *Henry Hunter* (Knolls Atomic Power Laboratory, General Electric) who spoke on programming a general-purpose digital computer for an analytical problem, reporting briefly on a study made recently at Knolls by an engineer on a training program. He had just finished an assignment with the analog group and expressed an interest in learning something about digital computers. Mr. Hunter therefore had him investigate a 704 program called NIDA which is supposed to make a 704 simulate an analog computer. The result was quite interesting.

The engineer did two problems, each in three different ways—on analog equipment, on the IBM 650 using a program written at KAPL and called DE2, and on the 704 using NIDA (Numerical Integrating Differential Analyzer). He found that the setup time was comparable in the three cases. The costs for getting a solution to a specific problem was also about the same in the three cases. The high-speed large-scale general-purpose digital computer can come close to competing on a cost basis.

"As a result of this study I am convinced," said Mr. Hunter, "that we will always have analog equipment. I am completely a digital man, and up to three months ago I would smile politely and say that I believed in analog equipment. But I didn't really! Now I do. And that goes for DDA's as well.

"I would like to justify my newfound conviction and also give a warning. Let me quote from the abstract of the IBM technical report for this NIDA program. 'To provide a convenient means for solving complex and nonlinear ordinary differential equations, a system has been devised that causes the 704 EDPM to behave like an analog differential analyzer.' The 704 does not behave like an analog computer by any means. In the first place, to prepare a program the user needs to learn to program in 704 language. This is quite different from the diagrammatic programming of analog equipment.

"Second, the output consists of a table of numbers, and there are few human beings who can look at a long table of numbers and immediately obtain the same information they can get from looking at graphs. Let me continue to quote: 'Use of this system involves interconnection of appropriate sub-routines in a manner analogous to the interconnection of operational amplifiers in an analog machine.' This statement requires the proper interpretation of the word analogous. I quote further: 'The subroutines are designed so that the user may compile the required connections automatically without much knowledge of digital-computer coding.' This is not true at all. 'Solving differential equations by this method takes no more setup time than that required by analog machines, and in many cases may be a good deal faster.' Yes, but the case in which it is faster is the case in which the setup for the digital machine is done without error. 'Integration is done by using Milne's formula. The system automatically adjusts the integration interval to take advantage of portions of the solution which can be computed with large intervals at no sacrifice of accuracy. Nonlinear functions may be expressed by a table of values in storage.' Therein lies the real reason that this turns out to be fast enough.

"There are two possible variations of NIDA—two ways in which it might be improved. One would be to construct a digital language more directly analogous to the plugboard setup of an analog computer. An example of such a language is the digi-

tal program written for DDA's. The other way is by use of a now nonexistent variation of FORTRAN, a powerful programming tool for the 704. FORTRAN is a high-speed—and I mean high-speed—and a very good, programmer. Usually programming for a digital computer is a process which is long and tedious, and which requires extreme accuracy, though all of the rules can be stated more or less simply. To use FORTRAN one needs write, with a few restrictions, the equations describing the problem to be solved. These equations are then keypunched into IBM cards which are fed to the 704. With the aid of FORTRAN, which is introduced by a master tape or stack of cards, the computer produces a program for solving the problem. The time required to use FORTRAN as contrasted to a human 704 programmer can vary from one-fourth to something like one one-hundredth as long."

CENTRAL S/C MEETING OF 9 SEPT. ON "HARDWARE TIE-INS"

Twenty-six representatives of nearly a dozen organizations attended the Central Simulation Council's meeting of September 9 at Boeing Airplane Company in Wichita, Kansas. The papers (on the topic of the day, "Hardware Tie-Ins") are abstracted below.

1. **"Hardware Tie-Ins"**—*Dick Ramsey* (Boeing, Wichita)—A discussion of the general concepts, problems, and engineering considerations involved in hardware tie-ins with analog computers. A specific example was presented in which the analog simulation of a B-47 in flight was tied into a hardware control system and autopilot. When used in this fashion it is possible to study the hardware in actual operation, thus pointing up difficulties or incompatibilities which would be missed in an "all-analog" simulation.

2. **"Research Flight Simulator"**—*Joseph Francis* (Boeing, Wichita)—A discussion of the Wichita Boeing Research Flight Simulator and its use as a hardware tie-in to the analog computer. The simulator uses an electro-hydraulic feel system and an instrument panel controlled by analog computer outputs. Stick and pedal signals are fed back into the computer to "fly" the simulated airplane. This device was later demonstrated.

3. **"Data Converters"**—*Harry Cordes* (Boeing, Wichita)—Analog outputs consisting of DC variables must be translated into "language" understood by the hardware tied into the computer. Various schemes for converting computer variables into modulated AC, mechanical position or velocity, and hydraulic signals were discussed. Analog-to-digital conversion methods and feedback transducers to complete the hardware tie-in loop were also considered.

Information (Without Theory)

The Study Groups originated by the Eastern Simulation Council seem to be effective media for the exchange of information. These groups, organized to consider specific aspects of simulation, get together before the regular Simulation Council meetings, and apparently spirited discussions sometimes ensue.

Before the last Eastern Simulation Council meeting the group on Physical Simulation backed away from their announced subject of simulation of linear forces on accelerometers* and discussed instead "Checks for Physical Simulation."

Obviously the best check would be to test the physical system in the expected service environment; e.g., fire a missile under combat conditions. However, this may be impractical. Perhaps the missile—or the combat—is not yet available. In any case, field test conditions often leave something to be desired. So, under the chairmanship of *Herb Wexler* (AVCO), this group discussed alternative methods of checking.

Mr. Widrewitz (RADC) suggested that changing variables at sensitive points in the system, preferably with noise, would give the probable operation.

Mr. Naess (Sperry Marine) said noise gave better results with their submarine simulator than sinusoidal inputs. He also suggested the use of previous test results to check subsequent simulations in cases of similar systems.

Herb said AVCO is going to investigate subjecting components to expected environmental pressures, vibrations, temperatures, and accelerations while they are still tied into the simulation. Thus a table used to position a gyro would have to withstand the gyro's expected environment.*

Means of comparing flight-test data with simulation data were also discussed. The usual technique is to try to reconstruct the flight. However, both *Mr. Naess* and *Mr. Wexler* said they were working on a technique of introducing flight-test data directly into the analog computer, thereby driving the simulated system.

Mr. Widrewitz and *Mr. Paskman* (Aircraft Armaments, Inc.) pointed out that the inclusion of a human in a simulated system loop while testing in the lab doesn't necessarily result in the same operation that would be experienced in flight when the same human is under stress.

* * *

The largest study group (17 members) was "Combined Analog-Digital Simulation" under the chairmanship of *Emile S. Sherrard* (National Bureau of Standards). At the last meeting *Dr. Harold Skramstad* (NBS) told how a loop including their SEAC was closed through a human and an analog computer to design a facility for studying complex systems involving humans, which the Wright Air Development Center Aero Medical Laboratory plans to use to determine the effectiveness of people in systems. Some analog-digital equipment built by Franklin Electronics and Servionics, Inc. is being used in connection with this work.

Problems in the use of digital computers for simulation result from the facts that the digital equipment must be able to tie in hardware, and that at present it will not solve the aircraft dynamics equations fast enough for real-time simulation.

Convair-Astronautics and Ramo-Wooldridge plan to use a digital computer for the low-frequency components of system response and an analog computer for the high-frequency ones, and have the digital correct the analog computer periodically. The trend is also to use the digital equipment with a single fixed program and make any changes required for the study in the analog section of the system.

However, the general consensus is that although there is much talk, and

*All who have considered this subject will sympathize!—Ed.

*Better get some Beechnut—this may take a long time!—Ed.

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The Model 912 Comvor, an audio frequency shift terminal, is used in the transmission of telemeter, telegraph or control signals over either wire line, microwave, or carrier. Up to 60 individual information channels are available in the audio spectrum.

Reliable frequency shift method of keying is used. All essential controls such as transmitter output level and receiver input level are included.

Each terminal contains its own power supply which provides an additional 60 milliamperes at both the transmitter and receiver for the operation of relays, stepping switches, selector magnets, and other components used in telemetering, control and telegraph applications.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DErfield 4-3100.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **70** on inquiry card.

Simulation Council —CONTINUED

many ideas have been discussed, nothing has really been done* toward proving out a real system.

We have an announcement from *George F. Forbes*, Industrial Mathematician (10117 Bartee Avenue, Pacoima, California), which states that the fourth edition of *Digital Differential Analyzers* is now available. The price has been decreased from $7.50 to $5.00, and additional information or an on-approval copy will be forwarded on request.

He Went Thataway!

Bob Sinker to president of Electrol, Inc., which is offering a punch-card-set function generator which "can increase your computation capacity by at least 10% . . . by eliminating all idle computer time resulting from non-linear function programming . . . adjustments, etc."**

Thot (From The Toastmaster, September 1957)

"What shall we say to the man who is afraid automation will wipe out his job?"

"If automation threatens to displace a man, then so long as he holds his job he is displacing a machine . . . Civilization has been threatened when men have become like machines . . . When a machine displaces a man, he has merely lost his job. When a man displaces a machine, he has lost his Manhood."

"Automation can mean emancipation not elimination when and if a man understands the limits of automation and his own potentialities as a human being."

*For at least one exception see AIEE CP No. 57-856, "A Two-channel Data Link for Combined Analog-Digital Simulation" by Jerry Greenstein (Convair-Astronautics, San Diego, Calif.). "This data link has been in operation since February 1957, and has by its use proven many of the advantages of an analog-digital interconnection . . . Currently, it is being used as an aid to simulating the Atlas Intercontinental Ballistic Missile . . . So far, this data link has been used successfully for the sampling of data at a 4,000-sample-per-second rate."

**Neat trick, if they can do it—Ed.—would vote the 10% figure the understatement of the week.

Computer Events

Joint Meeting of the Western Simulation Council, DDA Council, and Los Angeles Chapter of the Association for Computing Machinery

Date: 8 January 1958

Time: 1300

Place: Building 2 Auditorium, Ramo-Wooldridge Corporation, 5740 Arbor Vitae, Los Angeles, California

Subject: "Interrelationship of Analog and Digital Computers" The afternoon session will be a panel discussion followed by a demonstration of combined analog and digital computers using the Addaverter for Analog-to-Digital and Digital-to-Analog conversion. Following the afternoon meeting there will be an ACM dinner meeting and technical discussion of Digital Differential Analyzers. For further details of this session get in touch with Lloyd Hubbard at the IBM office in Los Angeles.

Central Simulation Council

Date: 3 February 1958

Place: Monsanto Chemical Corporation, St. Louis, Missouri

1958 High-Speed Computer Conference

Dates: 12-14 February 1958

Place: Louisiana State University, Baton Rouge, Louisiana
For more information write to Dr. Billie Townsend, Mathematics Department, LSU

Midwestern Simulation Council (tentative)

Date: February 1958

Place: Wright Air Development Center

Central Simulation Council (tentative)

Date: May 1958

Place: Wichita, Kansas; Joint meeting of Wichita University and Beech Aircraft

Western Joint Computer Conference

Date: May 1958

Place: Los Angeles, California

New positions in:

MISSILE SYSTEMS ELECTRONICS

Activities at Lockheed Missile Systems' Research Laboratory in Palo Alto cover virtually every field of electronics related to missile systems. Inquiries are invited from those who desire to perform research and development of a most advanced nature. Please address the Research and Development Staff, Sunnyvale 1, California.

Here staff members discuss a laboratory model of an airborne component of a guidance system. Left to right: Dr. R. J. Burke, telemetering; E. A. Blasi, antennas; K. T. Larkin, radar and command guidance; Dr. S. B. Batdorf, electronic division head; Dr. H. H. Leifer, solid state; S. Janken, product engineering.

Lockheed MISSILE SYSTEMS

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS

CALIFORNIA

INSTRUMENTS and AUTOMATION

New Instruments

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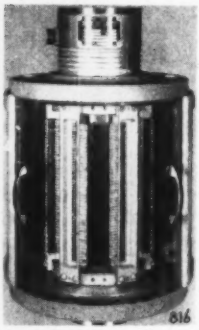
Vacuum 2292
Valves 2316
Vibration 2297
Volume 2290

FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 2341

MAGNETIC STORAGE DRUM

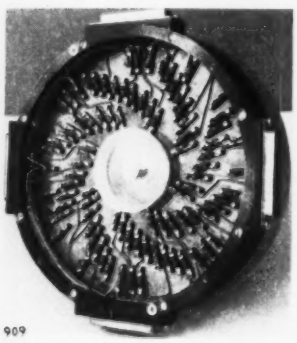
New Standard Model 512A magnetic storage drum meets exacting requirements of all permanent storage problems, yet is versatile enough for lab work; is 5" D and 12" L; capacities to 625,000 bits and speeds up to 12,000 rpm; 500-kc drum operation attainable; accommodates up to 240 magnetic read/record heads.—*Bryant Gage & Spindle Div., P.O. Box 620, Springfield, Vermont.*


816

For more information circle **303** on inquiry card.

MAGNETIC MEMORY UNIT

New high-capacity subminiaturized air-floating disc magnetic memory unit has 88 recording heads. Its information-packing density is said to be five times greater than that of average rotating magnetic memory unit.—*Autonetics Div., North American Aviation, Inc., Downey, Calif.*

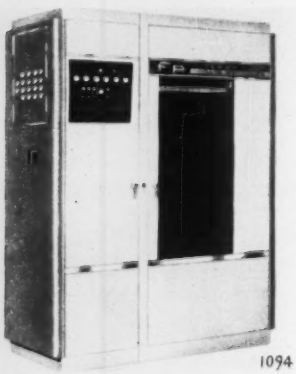

909

For more information circle **304** on inquiry card.

COMPUTING and DATA PROCESSING

DATA RECORDER OR LOGGER-CONTROLLER

New Series 1200 Data Logger can handle from 200 to 2000 input variables depending on scanning method used; performs zero offset, scaling, and characterization of non-linear inputs. It records all reading digitally on an automatic typewriter and, if desired, simultaneously on a punched tape for automatic process control.—*Fischer & Porter, 464 Jacksonville Rd., Hatboro, Pa.*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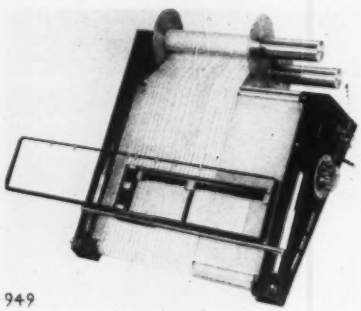

949

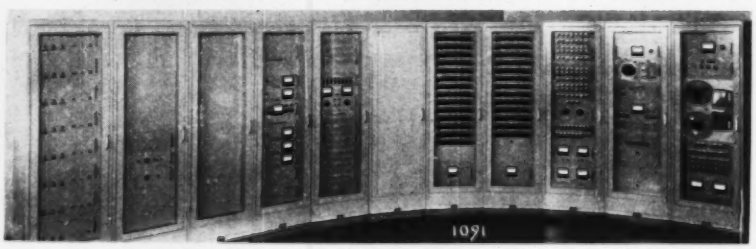
For more information circle **301** on inquiry card.

OSCILLOGRAM READER

New Model R-1 Data Reader can handle any number of linear or non-linear channels, correcting for linear or non-linear scale factors, as well as automatically correcting for zero line location of each channel. Among features: pushbutton operation forward and reverse from panel or with foot switch; vertical variable scale to count cycles, read frequencies, or space stations directly; *X-Y* type reading system, adjustable speed drive with variable transformer control.—*The Gerber Scientific Instrument Co., 162 State St., Hartford 1, Conn.*

For more information circle **302** on inquiry card.

ANALOG-TO-DIGITAL DATA PROCESSING SYSTEM


1091

New MADIS (Millivolt Analog-Digital Instrumentation System) comprises basically commutator, analog to digital converter, control and timing unit, digital tape recorder, and unique built-in test and monitoring system; can be expanded by using standard "building blocks." Among unique features: (1) "revolutionary" new relay matrix commutator which accepts 0 to ±10 mv signals directly; (2) magnetic tape format in which digital output of system is recorded, which permits direct play-in to IBM 701 or 704 or Remington Rand 1103A.—*Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.*

For more information circle **305** on inquiry card.

PROCESS MEAS'M'T and CONTROL

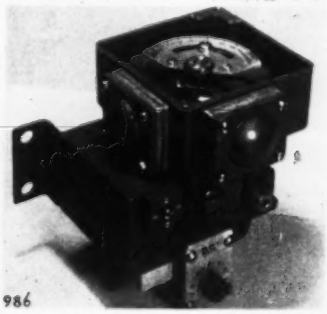
CHROMATOGRAPHY ANALYZER

New Chromomax Analyzer, said to be "the ultimate in Gas Chromatography instrumentation," can analyze as many as four process streams containing natural gases, vapors, low-boiling-point liquids and hydrocarbons, with eight such components in each stream. Among features: temperature control of analyzer unit from 50°C to 120°C with accuracy of better than 0.1 C° despite ambient swings as great as 60 F°; detectors consisting of special low-volume cells with hot wire filaments.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

For more information circle **306** on inquiry card.

PROCESS CONTROLLER

New Type VC pneumatic controller features easy proportional band adjustment from 2% to 500%; less than



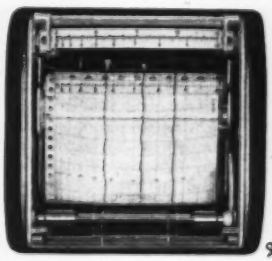
986

0.05% dead band; either remote pneumatic or local spring set point adjustment; is based on maker's null-balance-vector principle.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.*

For more information circle **307** on inquiry card.

PROCESS CONTROLLERS

Six new features added to standard panel-type Consotrol instruments: (1) pull-out Models 53 and 54 will



945

accommodate three pens; (2) Model 54 Consotrol recording control station can be tilt-mounted; (3) in addition to proportional, reset and derivative, it is now possible to achieve Batch Stabilog control which permits use of reset action on batch processes without "wind up" or "overshooting"

HI POWER...
in the palm of your hand!

Mu Beta

TELEMETRY
MODEL 201 rf
POWER AMPLIFIER

COMPACT • RUGGED • SHOCKPROOF

- **MINI** 2" x 2" x 3" . . . 15 ounces
- **RUGGED • SHOCKPROOF**
  Designed to MIL Missile Specifications
- **NEW AMPLIFIER CIRCUIT**
  Mu-Beta Mode Stabilized Negative Feedback

PERFORMANCE

Power Out	Power Drive	Power Gain	Plate Volts	Cooling
2 W	0.05 W	40	350	Radiation
10	0.5	20	400	Forced Air
20	2.0	10	450	Forced Air
40	5.0	8	550	Forced Air
TYPICAL LOW VOLTAGE OPERATION				
10 W	2 W	5	250	Radiation

Input and output impedance — 50 ohms
6.3 or 26.5 volt heater optional
Frequency Range 215-235 Mc/sec. (other ranges available)

Contractors for Electronisms • Mechanisms

Designers Mu Beta Manufacturers

SPECTRALAB INSTRUMENT CO. PRODUCTS PASADENA CALIFORNIA

404 North Halstead Avenue • RYan 1-7044

For more information circle **71** on inquiry card.

at start; (4) Auto-Selector action which provides a smooth transfer of reset control selectively for any number of related variables; (5) new type chart tear-off bar; (6) new automatic-manual switch handle. —*The Foxboro Co., Foxboro, Mass.*

For more information circle **308** on inquiry card.

HIGH-SPEED SEQUENTIAL OPERATIONS RECORDER

New Millisecond Operations Recorder (MOR System), for generating station as well as unattended sub-

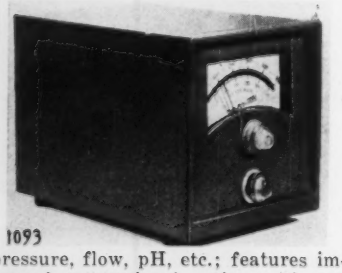
944

stations, automatically records all equipment operations sequentially on a printed digital tape (log sheet). Standard system can handle up to 400 points; smaller systems can be expanded to 400 by inserting one printed circuit card for each ten points.—*Fischer & Porter Co., 253 Jacksonville Rd., Hatboro, Pa.*

For more information circle **309** on inquiry card.

AUTOMATIC CONTROLLER

New Model 200 maintains temperature within as little as 1 F°; accomplishes equally close control of

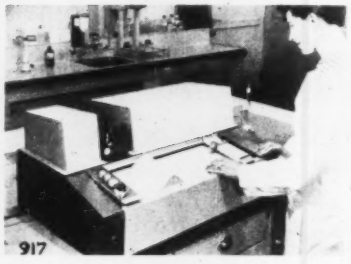

1093

pressure, flow, pH, etc.; features improved proportional action with use of electrostatic attraction to close contacts before limit point is reached by pointer. This anticipation prevents overshooting.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **310** on inquiry card.

AUTOMATIC RECORDING SPECTROPHOTOMETER

New IR-5 double-beam automatic recording spectrophotometer is a simplified low-cost infrared instrument,

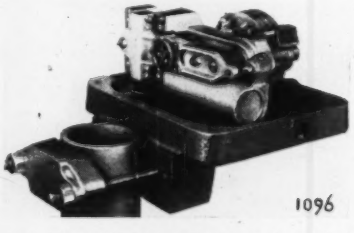

917

supplementing previously-announced single-beam IR-6. Its cost is said to be "about one-third the price of most commercially-available infrared instruments." Fixed controls, push button operation and automatic recording enable any technician tc easily operate it. Many accessories are available. —*Beckman/Scientific Instruments Div., Fullerton, Calif.*

For more information circle **311** on inquiry card.

TEMPERATURE AND PRESSURE TRANSMITTERS

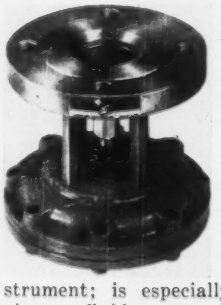
New Series 4600 (for temperature) and Series 4700 (for pressure) are pneumatic force-balance transmitters


1096

featuring "Balanced Beam" design which cancels positional error. Thermal systems and pressure elements are readily removed for change of range span. A derivative unit which compensates for lags in thermal system can be quickly added. Large pilot insures fast operation with long transmission lines. Unit is compensated for ambient temperature and barometric pressure.—*Mason-Neilan, Nahatan St., Norwood, Mass.*

For more information circle **312** on inquiry card.

PRESSURE AND LIQUID LEVEL TRANSMITTER



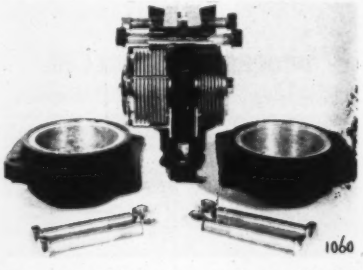
New low-cost Model "P" utilizes force-balance principle to convert pressures as high as 250 psi or as low as 0 to 100" water to a linear 3-15 psi signal to a pneumatic instrument; is especially suitable for viscous fluids or materials which solidify in static lines of pressure elements of conventional pressure transmitters; can be mounted horizontally or vertically on both open and closed tanks. Only the corrosion-resistant Inconel X diaphragm is wetted by measured material.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

For more information circle **313** on inquiry card.

FLOW-RATE, VOLUME

DRY-TYPE FLOW METER

New bellows-type flow meter accurate to within 0.5% maintains this accuracy even when ambient tempera-

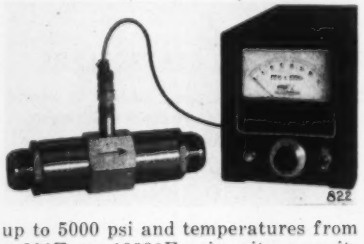

1060

ture changes by as much as 100 F° (55.5 C°) and static pressure reaches 2500 psi. Range is easily changed in the field by springs available in 15 ranges between 0-20" and 0-400" water.—*Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **314** on inquiry card.

TURBINE-TYPE FLOWMETERS

New Cox Type 20 lightweight turbine-type flowmeters feature 0.5% accuracy; handle liquids at pressures


822

up to 5000 psi and temperatures from −80°F to 1000°F, viscosity permitting; are available in stainless steel or aluminum, in capacities from 0.25 to 125 gpm. Flow indicator shown is Cox Type 7, direct-reading, which can be calibrated in gpm or pph.—*Commercial Research Div., George L. Nankervis Co., 15300 Fullerton Ave., Detroit 27, Mich.*

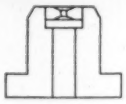
For more information circle **315** on inquiry card.

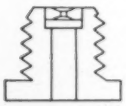
INDICATING FLOW SWITCH

New Model 234 Indicating Flow Switch features maker's Model 199 rupture-proof bellows unit. Differ-

PRECISION
JEWEL BEARING ASSEMBLIES . . .

for AIRCRAFT • ELECTRICAL
MECHANICAL and
MARINE
INSTRUMENTS





Sapphires set in brass, or other metal assemblies made in any quantity to close tolerance specifications are produced by Moser Jewel Company—*manufacturers of industrial jewels for over 50 years.*

Moser also provides highly polished pivots, staffs —silicon and spring loaded assemblies for high shock resistance.

SEND SPECIFICATIONS — DETAILED INFORMATION READILY GIVEN.

MOSER JEWEL COMPANY

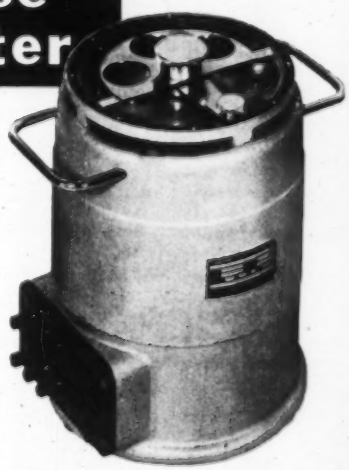
P.O. Box 150 • Perth Amboy, N. J.

"Manufacturers of all types of Industrial Jewels"

For more information circle **72** on inquiry card.

KNOPP Phase Shifter

Type Q



Every Degree between 90° leading to 90° lagging

You can have any leading or lagging phase angle by manually controlling the position of the rotor of the KNOPP PHASE SHIFTER.

Smoothly and continuously variable, it is quick and easy to use for testing electronic equipment and their control circuits, watt-hour meters, rotating standards wattmeters, power-factor indicators, induction relays, and instrument transformers.

Has two direct-reading scales. One is calibrated in degrees for the electrical angle of displacement; the other, in corresponding power-factor values.

Compensates for any phase displacement between current and potential of test setup that may be introduced by other portions of the circuit. Thus it gives true-power-factor-readings under all conditions.

The KNOPP PHASE SHIFTER offers superior performance, stability and high accuracy. Rated at 250 or 500 volt-amperes. Input: 120/240 volts, 3-phase, delta. Output: 120 or 240 volts, 3-phase, delta. Can be supplied in other ratings.

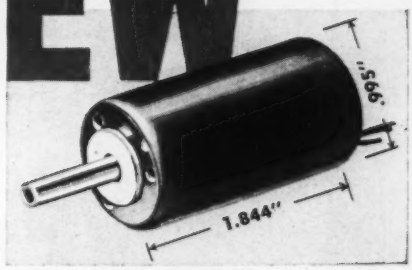
Write now for full details.

KNOPP INC.

Dept. A-8, 1307 66th St., Oakland 8, Cal.

For more information circle **73** on inquiry card.

NEW



EAD's 1" MOTOR

Operates *Directly* Off the 115 volt, 60 cycle Line!

...no step-down transformers, no dropping resistors necessary!

NOW—for the first time, a miniature, precision motor that operates from a 115 volt, 60 cycle line—*directly!* And this new EAD unit offers higher performance and higher capacities than other 1-inch diameter motors.

Typical stall torque is 0.7 ounce-inches—no problem starting in cold temperatures—with a running torque of 0.4 ounce-inches. Packed with power and precision, EAD's motor gets *more* air from bigger fans! For example, it easily drives a 3" fan blade at 3200 rpm. It drives a 4" fan blade at 2700 rpm with only 6 watts input.

Whatever the application, as a fan or blower drive or general purpose induction drive motor, if you want high-output, longer life, a precision, power-packed miniature to do a dependable job, your answer is this new EAD 1-inch motor. It has *much more* to offer in your vital applications.

Precision, Performance, Price—

Get All 3 at EAD!

TYPICAL SPEED-TORQUE CHARACTERISTICS	
SPEED RPM	TORQUE OUNCE-INCH
3500	0
2900	.50
2500	.75
2000	.95
0	.74

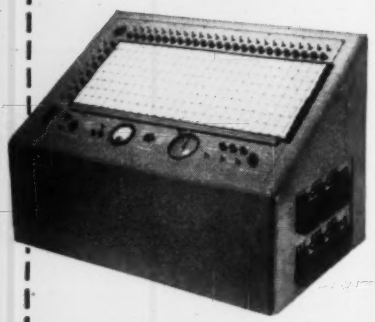
WRITE FOR MORE INFORMATION TODAY!

EAD Eastern Air Devices, inc.

347 Central Ave., Dover, New Hampshire

For more information circle **74** on inquiry card.

NOW! Accurate Functional Tests of Complex Relay Systems!



DIT-MCO Model 250F FUNCTIONAL TESTER

The Model 250F can automatically test the functional components and associated wiring of any complex relay system! The Functional Tester makes conclusive tests for continuity, continuity-discontinuity, discontinuity-continuity, insulation-resistance and shorts in relay systems involving switches, solenoids, actuators, resistors, etc. Features a timer for checking time-delay circuits and plugboard programming which permits efficient test planning and make-ready. Operation is easily mastered by non-technical personnel.

plus **These features of DIT-MCO's famous CIRCUIT ANALYZER!**

- **ELECTRONIC DETECTOR UNIT** . . . automatically tests quality to pre-set values!
- **TESTS UP TO 200 CIRCUITS** . . . in less than a minute!
- **MATRIX CHART** . . . pinpoints location and type of error automatically!
- **VACUUM-TUBE OHMMETER** . . . allows any circuit to be measured at any time during test!
- **UNIVERSAL** . . . adaptable to any relay system without modification!
- **STANDARD PARTS** . . . trouble free operation from telephone-type parts!

For additional information on the Model 250F or DIT-MCO Circuit Analyzers write:

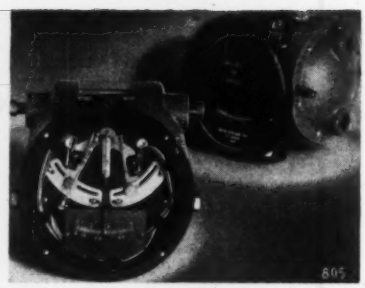
DIT-MCO, INC.

ELECTRONICS DIVISION

Box 12-13, 911 Broadway

Kansas City, Missouri

For more information circle **61** on inquiry card.



805

ential pressure ranges from 0-20" water to 0-50 psi with static pressure ratings up to 6000 psi. Can be supplied with low or high single setting, or low and high, low-low or high-high double settings.—*Barton Instrument Corp., 580 Monterey Pass Rd., Monterey Park, Calif.*

For more information circle **316** on inquiry card.

DRY CHEMICAL FEEDER

898

New Series A-690 Dry Chemical Feeder with self-cleaning feeding mechanism will feed up to 2.85 cfh, adjustable over a wide range by turning a knob. Hopper capacity of 3¼ cu ft. Arching in hopper is prevented by oscillating diaphragm-type agitators.—*Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.*

For more information circle **317** on inquiry card.

TEMPERATURE

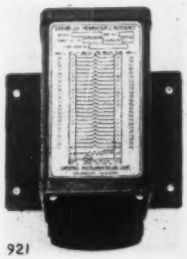
BEARING FAILURE PREDICTOR

911

New Lycoming Temperature Acceleration Indicator, said to be the only instrument of its type on the market, detects acceleration of temperature rise; warns against bearing failures. *Avco Mfg. Corp., Stratford, Conn.*

For more information circle **318** on inquiry card.

TC REFERENCE JUNCTION



921

New miniature multichannel (8, 12, or 24) thermocouple reference junction replaces ice baths, features temperature stability of 0.5 C° over entire environmental range of MIL-E-5272A. Units are preset to order at any point between 100 and 300° F; can be specified for use with any type or combination of types of thermocouples, for 110 vac or 28 vdc power. Fast delivery.—*Cardinal Instrumentation Corp., 4201 Redwood Ave., Los Angeles 66, Calif.*

For more information circle **319** on inquiry card.

TEMPERATURE MONITORS

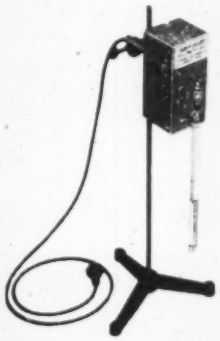
New completely automatic temperature scanning and recording units employ thermocouples; feature maximum of flexibility in application.—*Zeleny Instruments, 214 Third Street, Des Moines, Iowa.*

1090

For more information circle **320** on inquiry card.

TEMPERATURE CONTROLLER

New Model 83 Temp-Stat comprises a precision mercury regulator, an adjusting magnetic roto-head, and a sensitive electronic relay. Control sensitivity 0.005 C°; range −30°C to 260°C.—*Bayley Instrument Co., Box 538, Danville, Calif.*

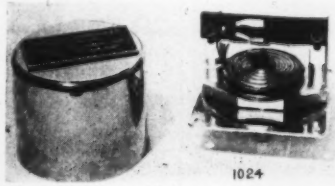


For more information circle **321** on inquiry card.

PRESSURE and VACUUM

PRESSURE PICKUP

New Series 6000 is said to provide voltage-pressure relation with "accuracy previously unattainable in pressure potentiometers." Available



1024

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.

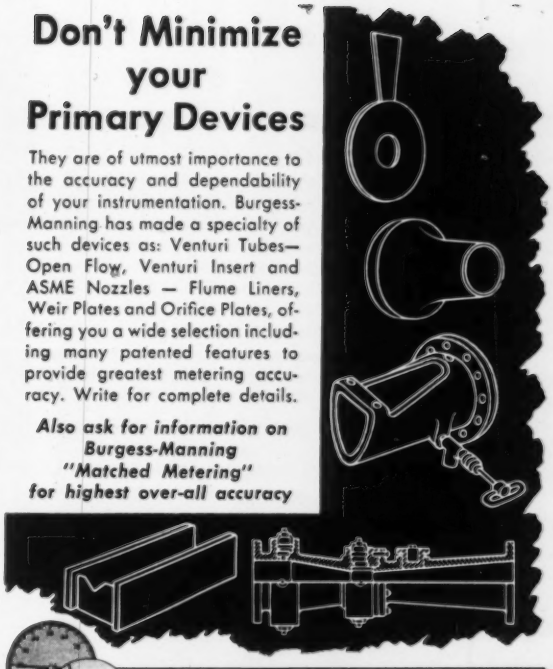
MARSHALLTOWN 3, IOWA

For more information circle **75** on inquiry card.

Don't Minimize your Primary Devices

They are of utmost importance to the accuracy and dependability of your instrumentation. Burgess-Manning has made a specialty of such devices as: Venturi Tubes—Open Flow, Venturi Insert and ASME Nozzles — Flume Liners, Weir Plates and Orifice Plates, offering you a wide selection including many patented features to provide greatest metering accuracy. Write for complete details.

Also ask for information on Burgess-Manning "Matched Metering" for highest over-all accuracy

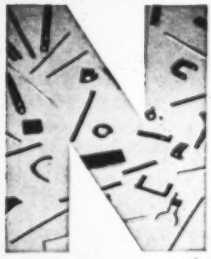


BURGESS-MANNING COMPANY
PENN INSTRUMENTS DIVISION
4120 Haverford Ave., Philadelphia 4, Pennsylvania

Instrumentation and Controls for water, steam, gases, sewage and industrial wastes

For more information circle **77** on inquiry card.

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



Ney's for "engineered" precious metal contacts, slip rings and alloys

Consult Ney's Engineering Dept. on any problem involving precious metals to improve your products.

THE J. M. NEY COMPANY
P.O. BOX 990 DEPT. F HARTFORD 1, CONN.
Specialists in Precious Metal Metallurgy since 1812

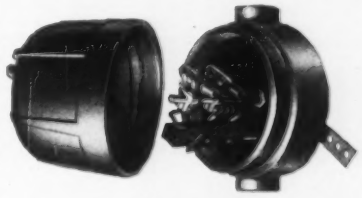
NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS

For more information circle **76** on inquiry card.

LEVER ARM CONTROLS

Explosion-Proof Weather-Proof Dust-Proof

(Suitable for Class 1 Group D; Class 2 Group E, F, G; NEMA, 1A, 2, 3, 4, 7, 9, 9A)



A small compact, explosion-proof case which contains Mercoid hermetically sealed mercury contacts mounted on an adjustable carrier attached to a movable shaft. Movement of shaft causes mercury switches to open/close electrical circuits.

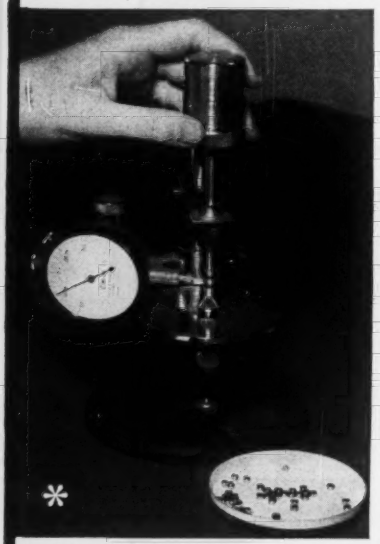
Standard types—SP-ST, SP-DT: Available with as many as five 4 amp. switches; three 10 amp. switches or three 25 amp. switches.

Write for Bulletin No. 33

THE MERCOID CORPORATION
4209 Belmont Ave., Chicago 41, Ill.

For more information circle **78** on inquiry card.

There's a *Bird*
JEWEL BEARING
to fit Your Need!



Bird can supply you with sapphire and borrosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:

Aircraft Instruments
Weather Recorders
Ammeters
Voltmeters
Wattmeters
Compasses
Dial Gages
Timers
Test & Recording Instruments
Marine Instruments

**Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.*

Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

Richard H. Bird & CO., INC.

1 SPRUCE ST., WALTHAM 54, MASS.

SAPPHIRE & GLASS JEWELS
PRECISION GLASS GRINDING
JEWEL MOUNTING & ASSEMBLY

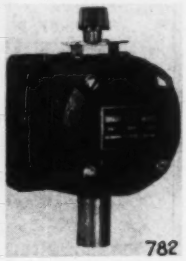
For more information circle **79** on inquiry card.

NEW INSTRUMENTS

ranges 0-5 to 0-5000 psi. Non-linearities of bellows or Bourdon tube are nullified by trimming carbon-film resistance element after final assembly and while pressure-actuated. By the same process, a specified non-linear output can be obtained.—*Computer Instruments Corp., 92 Madison Ave., Hempstead, L.I., N.Y.*

For more information circle **322** on inquiry card.

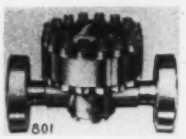
PRESSURE CONTROLLER


782

New Type H95 explosion-proof calibrated pressure controller is available in 22 models with adjustable range spans between 0 and 500 psi.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **323** on inquiry card.

PRESSURE REGULATOR


801

New Servo-Dome Pressure Regulator incorporates unique new features said to provide exceptional accuracy in flow and/or pressure control; is available for inlet pressures from 0 to 6000 psi; outlet pressures from 0 to 5500 psi; features balanced poppet providing long seat life from low seat load, low diaphragm $\triangle P$, damped downstream surge, and minimum cracking pressures; burst pressure four times rated pressure.—*Accessory Products Corp., Dept. X-28, 616 W. Whittier Blvd., Whittier, Calif.*

For more information circle **324** on inquiry card.

12" BOOSTER PUMP

757

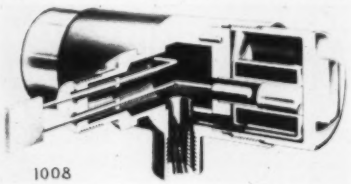
New B-12 high-capacity oil diffusion booster with 12" inlet diameter produces pumping speeds between 5200 and 6000 cfm (2450 to 2800 lps) at pressures from 0.8 to 5 microns. Forepressure tolerance of 900 microns makes new booster useful for installation in series with high-vacuum diffusion pumps where maximum gas handling capacity is required in submicron range.—*NRC Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.*

For more information circle **325** on inquiry card.

LIQUID LEVEL

LEVEL CONTROL

New Model CL-10 Dynatrol, for narrow-range proportional control of liquid, solid and slurry levels, fea-

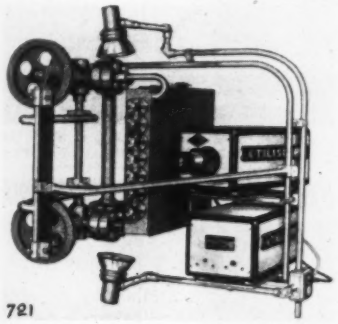

1008

tures electrical output signal that varies with immersion of 120-cps vibrating paddle in medium being detected; is rated for 3000 psi pressure, explosion-proof 115 vac, corrosion-resistant, any mounting position.—*Automation Products, Inc., 3030 Max Roy St., Houston 24, Texas.*

For more information circle **326** on inquiry card.

ITV GAGE MOUNT

New "Utili-Mount" permits quick inexpensive installation of closed cir-

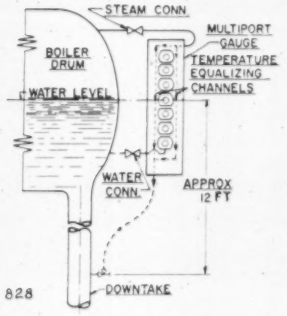

721

cuit TV to watch a water level gage.—*Diamond Power Specialty Corp., Lancaster, Ohio.*

For more information circle **327** on inquiry card.

DENSITY COMPENSATOR FOR BOILER GAGE

New Temperature Equalizing Multi-Port Gage Assembly minimizes



error caused by water in gage being cooler hence denser than water in drum.—*Diamond Power Specialty Corp., Lancaster, Ohio.*

For more information circle **328** on inquiry card.

Measure Specific Gravity Accurately!

...and from a remote point

The Petrometer remote reading Specific Gravity Indicator is accurate to .001 Sp. G. unit, with interpolation to .0005 unit! It's easy to install... and operates on the simple, sound principle of a differential bubbler.

An ideal instrument for plant or laboratory for measuring specific gravity of any liquid... paints, fuel, resins, pharmaceuticals, chemical solutions.

All functional parts are conveniently mounted on rear of panel, accessible by swinging open the cabinet door.

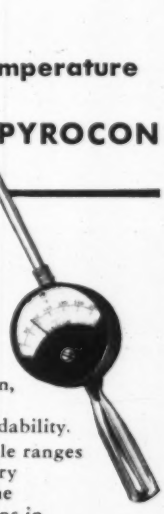
Send for Bulletin 7004

Petrometer CORPORATION

43-22 TENTH STREET, LONG ISLAND CITY 1, N.Y.

For more information circle **80** on inquiry card.

READ any surface temperature with Alnor® PYROCON



Equipment... material... metallic or non-metallic... flat, curved... revolving or stationary—you can read every surface temperature accurately in less than 3 seconds!

Compact, complete in precision design, this rugged instrument assures highest standards of speed, accuracy and dependability.

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **81** on inquiry card.

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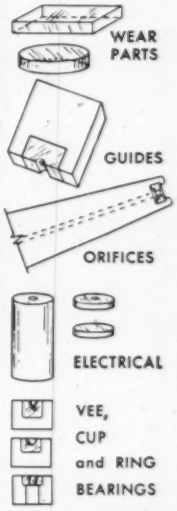
can Sapphire solve your wear or bearing problems?



If you need a surface that is absolutely free from "grain." If you need extreme hardness, high dielectric strength, resistance to heat and corrosion, then Sapphire could be the answer.

Sapphire can be cut, ground, polished, flame-formed and bonded to other materials.

But even after more than 50 years of specializing in only the tough, industrial jewel jobs, we can't tell you that Sapphire is the answer to your problems unless we see your blueprints and specifications.

For basic information, send for Sapphire Products Bulletin #3. Then ask us to get specific on YOUR problem.

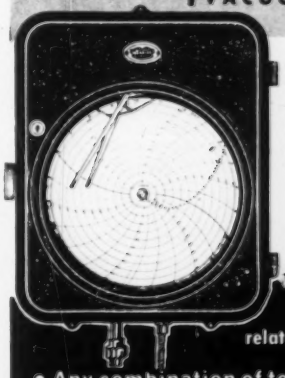
aurele m. gatti inc. "Precision Sapphire Products Miniature Sub-Assemblies"

Main Office and Factories — 526 Tindall Ave., Trenton, N. J.
Manufacturing Subsidiary — Guayama, Puerto Rico

For more information circle **82** on inquiry card.

WEKSLER INSTRUMENTS

Combination Recorders for TEMPERATURE, PRESSURE VACUUM AND HUMIDITY



ANALYZE PROCESS CONDITIONS!

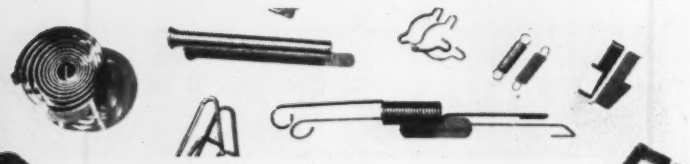
From two to four related records on a single chart!

• Any combination of temperature, pressure, and humidity can be recorded through Weksler Instrumentation. For a Permanent reference 8" chart size furnished for two pen recording. 10" and 12" chart size up to four pens.

For further information write to:

WEKSLER THERMOMETER CORP.
195 E. MERRICK ROAD, FREEPORT, L. I., N. Y.

For more information circle **83** on inquiry card.

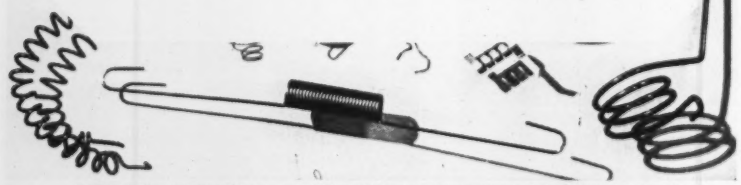


If springs will be important in the NEW products You plan to make...

LEWIS has the experience, the organization, the facilities to help YOU solve problems in Design, Production, and Purchasing ... to conserve your time, effort and lower your costs

SPRINGS AND WIREFORMS ARE OUR BUSINESS

Send Us YOUR Problem!



LEWIS SPRING & MANUFACTURING COMPANY
2648 W. North Avenue, Chicago 47, Illinois

Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

For more information circle **84** on inquiry card.

TELEMETERING

TELEMETERING OSCILLATOR

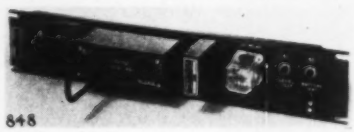
New Model 0-15 Little Jewel voltage-controlled telemetering oscillator, less than half the size of previous

models, features power requirement of 30 mw (1/100 that of smallest VCO formerly available) yet has improved linearity (0.5% of FBW) and stability (drift less than ±3%). Available on all standard RDB channels; 7.5% or 15% deviation.—*Dorsett Laboratories Inc., Norman, Oklahoma.*

For more information circle **329** on inquiry card.

"POWER OFF" ALARM

New AT-4 completely transistorized self-powered Power Off Alarm Transmitter can be used with any teleme-



tering or remote control systems; generates and transmits a tone of predetermined frequency through system carrier upon "power off" conditions. —*Hammarlund Mfg. Co., Inc.*, 460 *W. 34th St., New York* 1, *N. Y.*

For more information circle **330** on inquiry card.

POSITION PICKUP FOR TELEMETERING

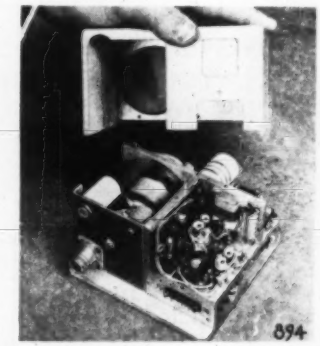
New Telemetering Position Transducer provides a frequency change of 4% in associated oscillator circuit

per inch of shaft movement. Output signals of up to ten such units can be mixed and transmitted on a single channel to a remote receiver which separates signals by filtering. Each unit operates with a center frequency from 900 to 6,000 cps.—*G. L. Collins Corp.*, 2820 *Hullett St., Long Beach*, 5, *Calif.*

For more information circle **331** on inquiry card.

TELEMETERING TRANSMITTER

New transistorized 200-watt transmitter extends range of telemetering, reduces weight and space. Available



units transmit in 215-235-Mc range with frequency stability of 0.01% up to 71°C. (Higher frequencies possible with minor modifications.) Basic unit can be modified to operate at power outputs as low as 25 watts.—*Texas Instruments Inc., Apparatus Div., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **332** on inquiry card.

POSITION, VIBRATION

DISPLACEMENT PICKUP WITH PLUG-IN TERMINAL

New displacement pickup with a plug-in terminal for lead wires features exceptionally low null voltage of 20 mv rms (max), whence a sensitivity of 0.49 mv per 0.001" displacement per volt input at 2500 cps. Input 12.5 v, 2500 cps single ended and grounded; range ±0.63".—*Auto-Matic Timing & Controls, Inc., King of Prussia, Penna.*

For more information circle **333** on inquiry card.

VIBRATION PICKUP

New Type 4-120 vibration pickup weighing less than 5 oz will operate continuously between −65°F and 500°F. Frequency range 40 to 2000 cps; linearity ±4% of reading (for constant frequency) over entire range. Maximum acceleration without damage 50 *G*.—*Consolidated Electrodynamics Corp. Pasadena, Calif.*

For more information circle **334** on inquiry card.

VIBRATION DETECTOR

New Model 65-LS (low sensitivity) malfunction detector has a range of 0-4.5 *G*, is cased in an explosion-proof

NEW Development!

HICKOK

250° Arc

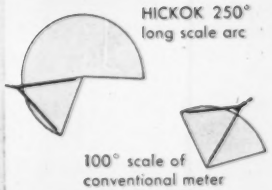
LONG SCALE METERS

Save Valuable Panel Space

The scale in these new instruments is 2½ times as long as conventional meters. A 3½" HICKOK 250° meter has a scale length equal to a conventional 6" instrument.

These exclusive panel style 250° meters fit a smaller space though still provide easier, more accurate readings.

Available in all popular AC or DC ranges. Square, semi-flush or round flush cases. 2½" thru 5½" sizes.

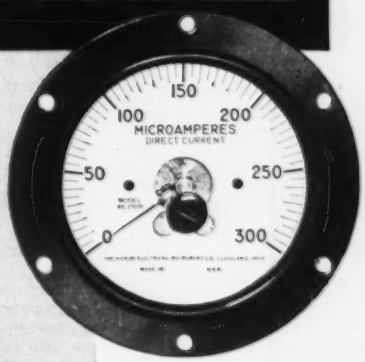


UNIFORM SCALE

Evenly Spaced Scale Divisions

RUGGEDIZED and SEALED

AC rectifier or DC types



The highly efficient HICKOK shock mount construction permits pointer and scale divisons to be easily read when meter is under vibration. The DC movement is a precise and rugged internal pivot type. The AC movement is of the iron vane principle with unusually efficient magnetic damping for ruggedized purposes. Case is permanently sealed at the factory, however, may be opened and resealed.

These instruments meet military specifications and are in volume production. Your inquiry is invited. Kindly list details of your requirements or request Catalog No. 33.

THE HICKOK ELECTRICAL INSTRUMENT CO.

10519 DuPont Avenue • Cleveland 8, Ohio

For more information circle **85** on inquiry card.

HEAVY-DUTY FLASHER

New Type BF flasher, designed for long life with loads up to 2 amp at 120 vac or 32 vdc, weighs 9 oz; combines two thermal relays and one magnetic relay in a circuit in which load current is handled by magnetic relay. Thermal relays govern the on and off portions of cycle which, therefore, is unaffected by load current or load contact erosion. New unit is compensated for ambient temperature variation from −65°C to 125°C; will withstand aircraft vibration and shock requirements.—*G-V Controls Inc., 28 Hollywood Plaza, East Orange, N. J.*

For more information circle **341** on inquiry card.

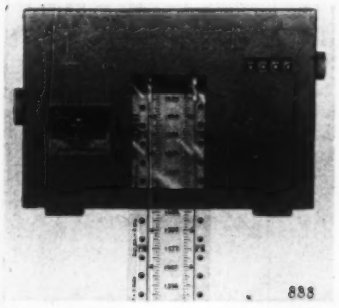
DOUBLE PRESET COUNTER

New Model U 280-Z, specifically designed for controlling processes requiring a warning, or deceleration signal, has two predeterminations, each independently settable to a total of 99,999, with knock-off by two sp-dt switches. Counters add and subtract to a maximum speed of 5,000 rpm.—*Presin Co., 12128 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **342** on inquiry card.

PREDETERMINED PRINT-OUT COUNTER

New Tally-Print monitors a machine or process. At predetermined intervals, total elapsed time or total number of units monitored in that interval is printed on its time-marked tape. In addition, a visual cumulative total is provided for longer periods. Standard print-out intervals are 5, 15, 30 or 60 min. Maximum speed 300 impulses a minute.—*Standard Instrument Corp., 687 Broadway, New York 12, N. Y.*

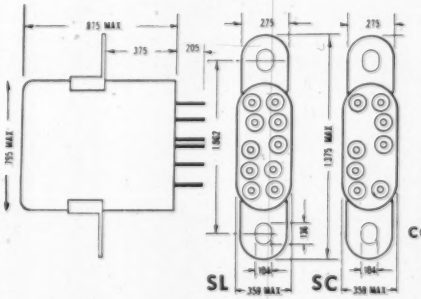


For more information circle **343** on inquiry card.

CRYSTAL-CASE SIZE! PERMANENT MAGNET DESIGN.
SHOCK: 100g. VIBRATION: 30g 55 TO 2000 cps. NO CONTACT OPENINGS.

SC NON-LATCHING TYPE—This micro-miniature relay sets new standards —in design, in performance, in reliability. Yet the SC conforms to standard dimensions and circuitry and may be used to replace ordinary crystal-case relays. A permanent magnet in the structure provides *at least twice the contact pressure found in relays of comparable size.*

SL LATCHING TYPE—Unique magnetic latch assures exceptional contact pressure. A 1 watt, 3 ms. pulse to either coil transfers contacts. Transfer time is only 0.5 ms. Has the same exceptional shock and vibration characteristics as the SC.



SC and SL Series Engineering Data

Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board. (2) Hook end solder for one #20 AWG wire.
Enclosure: Hermetically sealed.
CONTACTS: Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. AC, resistive.
Pressure: SC—13 grams min.; SL—16 grams min.
COIL: Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.
MOUNTINGS: Bracket, stud and plug-in.

GENERAL: Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: -65°C. to +125° C.
Weight: 17.5 grams (5/8 oz.).

P&B Standard Relays are available at your local electronic, electrical and refrigeration distributors

Potter & Brumfield, inc.

PRINCETON, INDIANA · SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

For more information circle **87** on inquiry card.

Equipment designers who demand more than "shelf item" specifications, rely on CIC for dependable delivery of ultra-precise potentiometers.

The result of CIC research, carbon film potentiometers are setting new standards of accuracy, life at higher speeds and performance reliability.

CIC has assisted many firms in a wide variety of industrial instrumentation, military fire control and flight guidance equipment.

Why not discuss your specific requirements with us?

*New carbon film techniques assure virtually infinite resolution; linearity to .01%, sine-cosine to .025%; compact ganging; precision ball bearing servo construction.

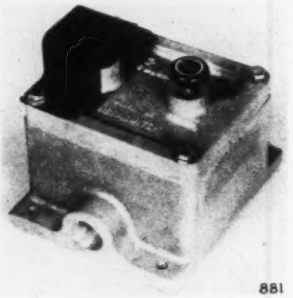
"For Precision Performance...specify CIC"

Detailed Technical Data Sheets available on request.

CIC COMPUTER INSTRUMENTS CORPORATION
92 Madison Ave. • Hempstead, Long Island, N. Y.

For more information circle **86** on inquiry card.

NEW INSTRUMENTS



881

housing; is available with sp-dt switch, and split-contact n-o switch; both rated at 7 amp 460 vac.—*Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **335** on inquiry card.

INERTIA SWITCH

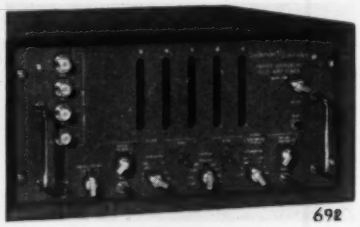
New miniature Inertia Switch, said to be "the smallest yet known," has one moving part, frictionless in operation, which momentarily closes electrical contacts, following impact or acceleration above a preset value. Setting adjustable from 1.5 *G* up, tolerance 0.15; volume ½ cu in; weight ¾ oz.—*Safe Lighting, Inc., 527 Lexington Ave., New York 17, N. Y.*

For more information circle **336** on inquiry card.

TIME, FREQUENCY, SPEED, COUNTING

PRESET TIMER-COUNTER-RATEMETER

New Models 7351 (5-digit readout) and 7361 (6-digit) Preset Universal EPUTs and Timers are exceptional-



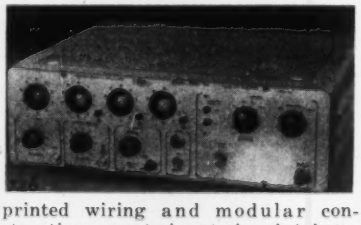
692

ly flexible: they can perform seven distinct operating functions: E/UT, time-interval measurement, period, totalize, frequency ratio, scan, and time-interval generating.—*Beckman/Berkeley Div., 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **337** on inquiry card.

FREQUENCY COUNTER

New Model 7340C Frequency Indicator and Counter, easily operated by non-technical personnel, features

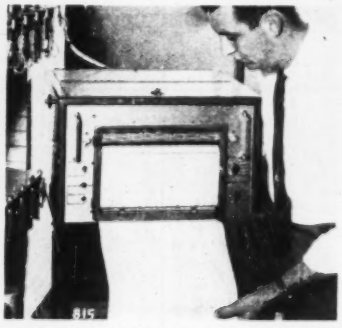


printed wiring and modular construction; counts input signal (photocell, tachometer, generator, flowmeter, etc.) during a known time base (0.1 sec., 1 sec., 10 sec) and displays with automatic decimal point location, in cps, kc, etc. Indication can be held or instrument can recycle with controllable display time.—*Electro Pulse, Inc., 11861 Teale St., Culver City, Calif.*

For more information circle **338** on inquiry card.

TIME-OPERATION RECORDER

New Event Recorder simultaneously records up to 100 channels of on-off information; has chart speeds



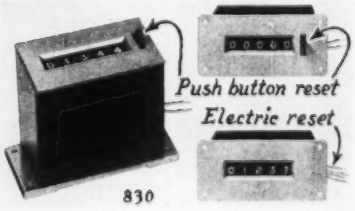
815

from about 10" per second to 10" per day selectable at test site or by remote control.—*Brush Instruments, Div. of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio.*

For more information circle **339** on inquiry card.

ELECTRIC COUNTER

New YE Series of high-speed electric counters count up to 1500 cpm and can be instantly reset to zero



830

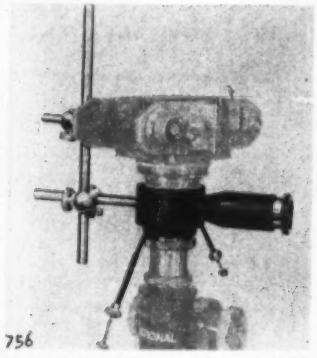
either electrically or with a flick of a push button; are the first American-made counters with instant reset and, with ⅜" white figures on a black background, are said to be the most easily read electric counters available.—*Durant Mfg. Co., 1914 North Buffum St., Milwaukee 1, Wis.*

For more information circle **340** on inquiry card.

PHOTOGRAPHY

PHOTOMICROGRAPHIC ATTACHMENT

New low-cost attachment converts any microscope into a precision photomicrographic outfit; is equipped

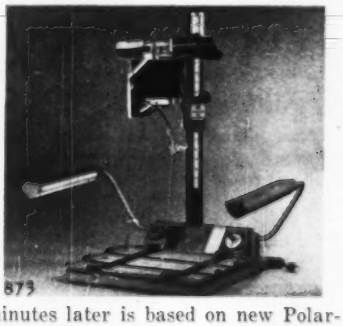


with adjustable stabilizing rods.—*National Instrument Co., 2701 Rockwood Ave., Baltimore 15, Md.*

For more information circle **350** on inquiry card.

INSTANT-SLIDES SYSTEM

New photographic system that makes it possible to snap a picture and project it on a screen a couple of

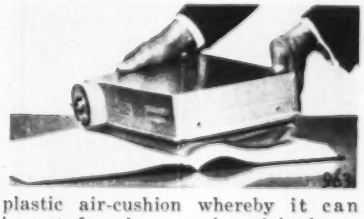


minutes later is based on new Polaroid Land Projection Film which has a speed of 1000.—*Polaroid Corp., Cambridge 39, Mass.*

For more information circle **351** on inquiry card.

PHOTOCOPY MACHINE

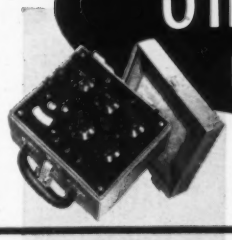
New brief-case Contoura-Portable takes normal office lighting and same setting for all material; has a unique

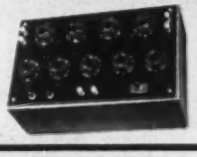


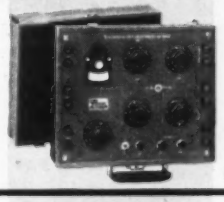
plastic air-cushion whereby it can be put face-down on bound books to produce a copy of anything printed, written or drawn, in 30 seconds at 11 cents per page.—*F. G. Ludwig Co., Inc., 103 Coulter St., Old Saybrook, Conn.*

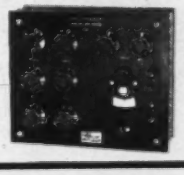
For more information circle **352** on inquiry card.

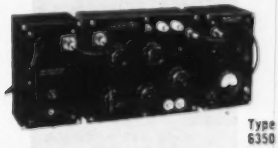
Shallcross BRIDGES


Types 6100 and 6101


Type 6320


Type 638-R


617 Series


Type 6350

ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Avenue, Collingdale, Pa.

Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "—" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^3 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V. 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "—" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111.111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111.111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω. * Except 617G, 0.01Ω.

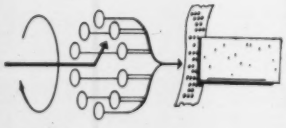
For more information circle **89** on inquiry card.

DIGITIZERS REPLACE COMPLEX ELECTRONIC EQUIPMENT

DIGITIZER®

[Analog to Digital]

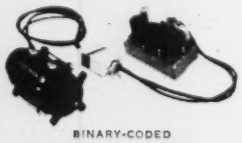
The Coleman **DIGITIZER** provides a simple, economical, and reliable method of recording, in digital form, the analogs of temperature, pressure, voltage, strain, distance, etc. This record may be produced automatically by printers, punched cards, electric input typewriters, and perforated-tape machines.



Shaft rotation input. Unambiguous contact setting. Digital contact output.

DECIMAL DIGITIZER

BINARY DIGITIZER



BINARY-CODED DECIMAL DIGITIZER

[Digital to Analog]

Conversely . . . DIGITIZERS can also be used in automation systems as a positioning device to convert digital inputs to predetermined shaft position.

Your name.....

Company.....

Address.....

.....

Write for Free Data File.
Mention your application.

Coleman

Engineering Company, Inc.
6040 West Jefferson Boulevard
Los Angeles 16, California

For more information circle **88** on inquiry card.

NEW INSTRUMENTS

NUCLEONICS

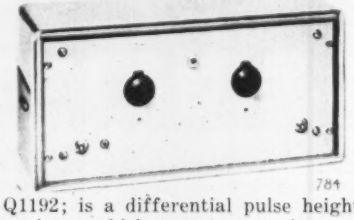
NEUTRON DETECTOR TUBES

New Model VXN-1 for detecting thermal neutrons (built to ORNL spec Q-1503) and Model VXN-2 for detecting fast neutrons (built to ORNL spec Q-1381) feature exceptionally long service lives. Both are used extensively at Oak Ridge Tower Shielding Facility and Bulk Shielding Facility.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **344** on inquiry card.

DIFFERENTIAL ANALYZER

New Model 695, for use in scintillation spectrometry, proportional counting, etc., is constructed to ORNL spec

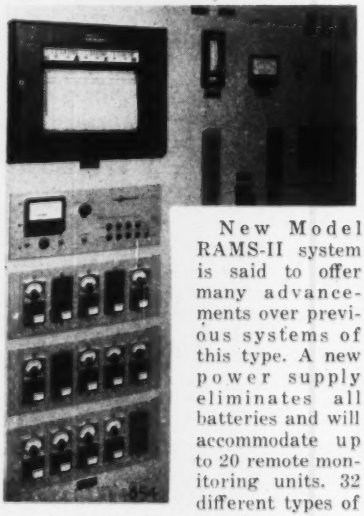


784

Q1192; is a differential pulse height analyzer which passes on to its output only those pulses whose peaks fall between two predetermined amplitude levels and rejects all other signals.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **345** on inquiry card.

NUCLEAR REMOTE AREA MONITORING SYSTEM



854

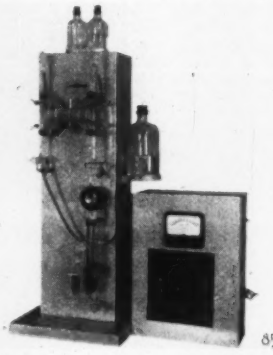
New Model RAMS-II system is said to offer many advancements over previous systems of this type. A new power supply eliminates all batteries and will accommodate up to 20 remote monitoring units. 32 different types of standard plug-in monitoring stations satisfy all requirements, with ranges of 3 or 6 decades from 0.01 mr/hr and up.—*Jordan Electronics Co., 3025 W. Mission Rd., Alhambra, Calif.*

For more information circle **346** on inquiry card.

LAB EQUIPMENT

AUTOMATIC TITRATOR

New Type ASD-1 Automatic Sulfur Determinator overcomes objections usually associated with manual

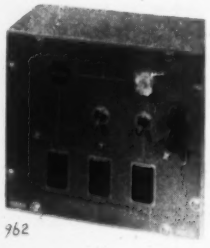


858

titration; determines end point photoelectrically then shuts off flow of titrant and flashes a signal light.—*Lindberg Engineering Co., Lab. Equipment Div., 2450 W. Hubbard St., Chicago 12, Ill.*

For more information circle **347** on inquiry card.

LAB CONTROL STATION



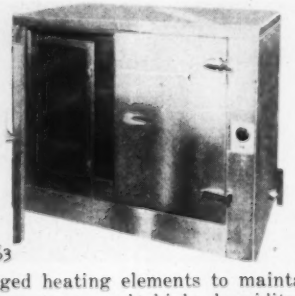
962

New Electronic Control Box features new circuit with improved operating characteristics; has 3 plug-ins for controlling heaters, stirrers, alarms, constant-temperature baths, etc. Duplex terminals connect to (for example) liquid level controller and temperature regulator.—*Labline, Inc., 3070-82 W. Grand Ave., Chicago 22, Ill.*

For more information circle **348** on inquiry card.

INCUBATORS

New wet type Univect gravity convection incubators utilize a water pan below working chamber with sub-



863

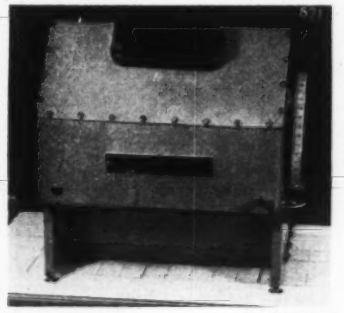
merged heating elements to maintain temperature and high humidity.—*National Appliance Co., 7634 S. W. Capitol Hwy., Portland, Oregon.*

For more information circle **349** on inquiry card.

DIMENSIONAL GAGING

OPTICAL COMPARATOR

New Model 167 enables fast and accurate comparison of similar or identical objects and determining differ-



ence between them, both qualitatively and quantitatively. Among subjects: circuits, handwriting samples, fingerprints, etc.; also to superpose an assembly drawing on a work surface for assembly of small parts; also for three-dimensional objects.—*Engineering & Optical Div., Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **360** on inquiry card.

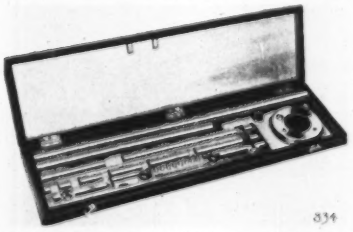
THICKNESS OR DENSITY GAGING SYSTEM

New Gammascan measures thickness or density of such continuously produced materials as plate and sheet metal, glass, thick sections of plastics, etc.; utilizes a modified scintillation detection method; provides output signal usable for control and continuously records thickness. Time response is in millisecond range.—*The Budd Co., Nuclear System Div., 2450 Hunting Park, Ave., Philadelphia 32, Pa.*

For more information circle **361** on inquiry card.

LENGTH BARS

New Matrix Combination Length Bars, available in three types and grades (Workshop, Inspection and



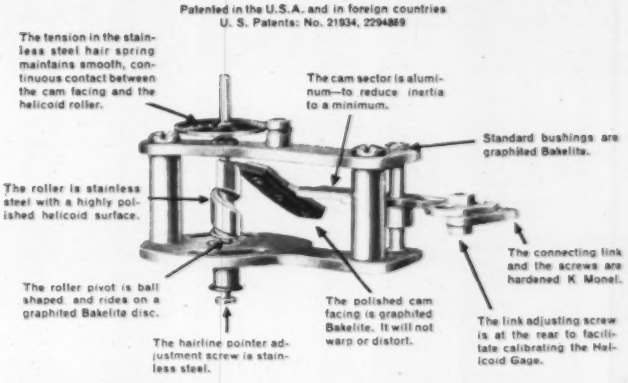
834

Master Reference) solve problem of determining length beyond scope of Standard Gage Block Set, but to equally high precision. If required, accuracy of determination of actual length can be certified to 0.000007". Available in individual units or sets and with accessories for general use. —*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle **362** on inquiry card.

Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294889
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials —alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

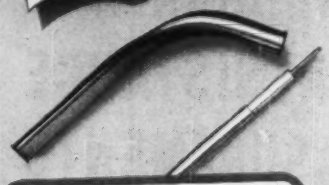
Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

For more information circle **91** on inquiry card.

TUBING

STRAIGHT . . . PREFORMED OR COAXITUBE



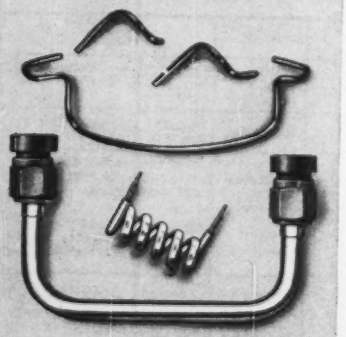
FROM .010" TO 1.000" TO YOUR SPECIFICATIONS

Whatever you need in tubing to any size, shape or alloy . . . Precision can supply it with precision accuracy, extra quality and at no extra cost.

Oxygen free copper and copper alloy tubing, nickel and nickel alloys, aluminum alloys, stainless steel—tubing for all electronic applications. Formed to exact specifications, single or double flared ends, complete with Standard A N Fittings.

Precision Coaxitube—A semi-rigid coaxial pair of conductors, sub-miniature sizes—low as .050" diameter, polyethylene or teflon dielectrics. Excellent mechanical properties, efficient shielding, low noise level for communication networks and missiles guidance systems — protected from false signals.

Let Precision's engineers help you improve your product and reduce manufacturing costs with preformed tubing, assemblies and Coaxitube. Write for folder and full details to Precision Tube Company, Inc., Dept. 4, North Wales, Pa.



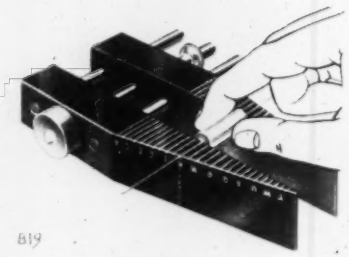
PRECISION TUBE COMPANY

For more information circle **90** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

LEAD BENDER

New No. 600 Universal Bending Block, for bending leads during assembly to accurately register with

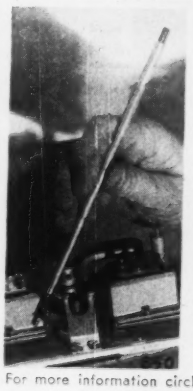


819

their holes in printed circuit panels, eliminates plier damage to leads and components; enhances appearance; saves time.—*By-Buk Co.*, 4314 *W. Pico Blvd., Los Angeles* 19, *Calif.*

For more information circle **353** on inquiry card.

SCREW-HOLDING DRIVER



New screw-holding screw driver provides a quick, sure way to hold a screw in position. As assembler pushes forward, tiny twin bits expand inside screw slot. Screw will not be released until it is firmly seated in thread.—*H. J. Co.*, 268 *Marlow Drive, Oakland, Calif.*

For more information circle **354** on inquiry card.

CABLE WRAPPING

New Amp-Spirap speeds and simplifies subassembly operations; is a unique spirally-cut plastic wrapping

904

that eliminates tedious cable lacing, insulation damage, and pulling or wires through spaghetti tubing; is quickly applied to wire bundles up to 3½" dia; is quickly unwound to allow wires to be added, removed, or relocated.—*AMP Inc., Harrisburg* 19, *Pa.*

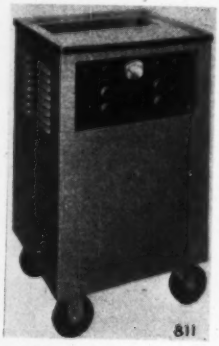
For more information circle **355** on inquiry card.

PRECIOUS-METAL WIRES

Two new precious metal wires for resistance windings in diameters as small as 0.0005": (1) Ney-Oro G, a gold-platinum-silver-copper alloy having a resistivity of 80 ohms/cmf; (2) Paliney #7, a palladium-platinum-gold-silver-copper alloy having a resistivity of 200 ohms/cmp. Both have high tensile strength and resist corrosion; can be furnished bare or enameled; are also available as sliding contacts or wipers in standard wire forms or to specs.—*The J. M. Ney Co., Dept. F, P. O. Drawer* 990, *Hartford* 1, *Conn.*

For more information circle **356** on inquiry card.

ULTRASONIC CLEANER



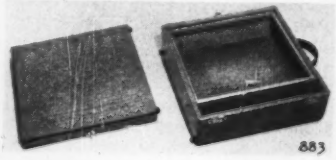
811

New Model R-50 self-contained cleaning set-up includes a heater, temperature control, filtration and recirculation system in addition to the ultrasonic generating equipment. Tank itself is 6x16x11" with 5-gal total working volume. Bottom-mounted transducers have a rated input of 250 rf watt average. Even insoluble soils can be removed in minutes—sometimes seconds.—*Branson Ultrasonic Corp.*, 40 *Brown House Rd., Stamford, Conn.*

For more information circle **357** on inquiry card.

INSTRUMENT CASE

New wooden case designed to house different types of electronic instruments features space for a panel, and



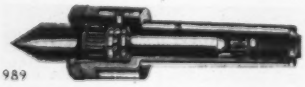
883

partitioned space for batteries or spare parts, accessible through top part. Depending on layout, space can be made accessible from back. Various sizes and designs.—*Scientific Wood Cabinet Co.*, 80-86 *Holmes St., Belleville* 9, *N. J.*

For more information circle **358** on inquiry card.

LIVE CENTERS

New Precision Frictionless Live Centers are designed to have a life expectancy of "practically 10,000



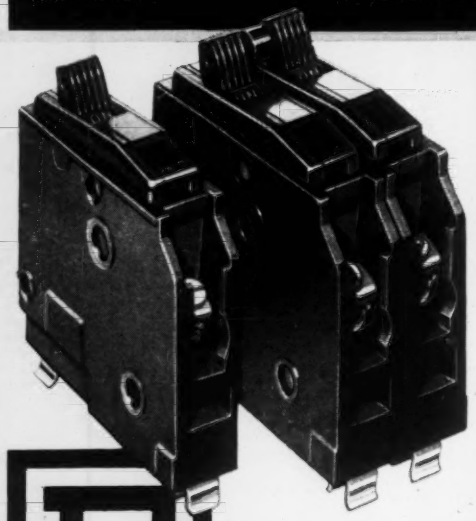
989

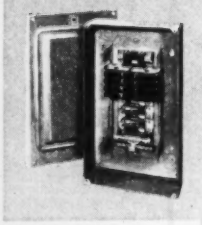
working hours"; hold runout within 0.0001" total indicator reading; have to be oiled but once a year.—*George Scherr Co., Inc.*, 200 *Lafayette St., New York* 12, *N. Y.*

For more information circle **359** on inquiry card.

CHACE THERMOSTATIC BIMETAL

ACTUATES ANOTHER PRECISION PRODUCT . . .





A Product of
Square D Company
Detroit, Michigan

QO CIRCUIT BREAKER LOADCENTERS

The QO Loadcenter by Square D Company is typical of the skillful design and fine construction which distinguishes this famous manufacturer's entire line of products. Trip elements are the highly-efficient thermal and independent magnetic type. Overloads are controlled by a direct-heating bimetal element, protected by a special "arc chamber" which completely shields the sensitive bimetal from hot blasts. An auxiliary bimetal element provides temperature compensation against the heat of the sun, furnaces, enclosures, etc. Silvered plug-in jaws and silvered connectors are used to provide better line connections. Operating handles are designed for quick, positive trouble-circuit identification. And the swing-grip mounting lets the installer mount the breaker in a matter of seconds.

With such painstaking attention to design details, it is only natural that Square D should specify Chace Thermostatic Bimetal for the QO breaker. Precision-rolled to the closest tolerances — specially processed for a *permanent* metal bond—tested under various conditions—and carefully inspected to assure quality of product, Chace Thermostatic Bimetal provides instantaneous, automatic, and unfailing protection of valuable equipment. In *your* product planning, specify Chace Thermostatic Bimetal . . . ultimate result of over a third of a century's exclusive production of precision bimetal.

Remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements made to your specification. (We do not manufacture complete controls or any other devices in competition with our customers.) Write today for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal", containing many pages of design data.

IT BENDS WITH THE HEAT

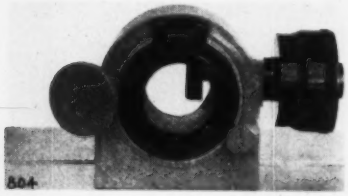
W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **92** on inquiry card.

NEW INSTRUMENTS

CHART LAYOUT & CHECKING INSTRUMENT

New Chart Layout Instrument provides an economical yet accurate method of making chart-gages for



optical comparators. Among uses: (1) making chart-gage layouts in pencil, ink, or scribed lines on chart material directly on viewing screen without computations because direct readings are made at micrometer. (2) Checking accuracy of charts furnished by vendors. (3) Checking accuracy of magnification of the optical comparator itself.—*Automation Gages, Inc., Sibley Tower Bldg., Rochester, N. Y.*

For more information circle **363** on inquiry card.

BRIGHT BEAM LAMP

New Industrial Bright Beam Lamp, a new kind of industrial lamp for close-work operations, is said to increase production and reduce errors and spoilage. Light spot variable from ⅝" to about 3" by sliding focus tube.—*Edmund Scientific Co., Barrington, N. J.*

For more information circle **364** on inquiry card.

MICRO PROJECTOR

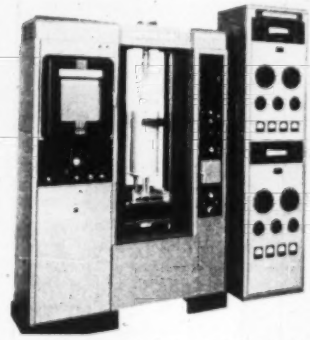
New model of maker's Micro Projector features: (1) horizontal stage; (2) comfortably inclined screen; (3)

fixed standard magnifications changed by slipping different projection lenses into a vertical socket in which they rest by gravity; (4) when using cross slide, both measuring motions are performed on the same horizontal plane.—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*

For more information circle **365** on inquiry card.

HIGH TEMPERATURE TENSILE TESTING EQUIPMENT

New equipment for tensile testing at temperatures up to 2200°F, for use with maker's Testing Instrument,



can exert more than 1500 lb force. Temperature within furnace is said to be regulated within 2 F°. A dual furnace arrangement (illus.) can be installed.—*Instron Engineering Corp., 440 Hancock St., No. Quincy, Mass.*

For more information circle **366** on inquiry card.

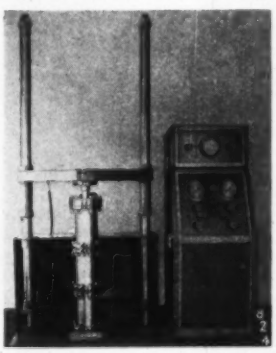
CREEP TESTING EQUIPMENT

New high-temperature creep testing equipment makes possible highly accurate creep measurements at temperatures up to 2200°F in vacuum or artificial atmosphere. Load capacity 2000 lb at 2200°F. Vacuum pumping and gaging apparatus can be supplied. —*Instron Engineering Corp., 440 Hancock St., Quincy, Mass.*

For more information circle **367** on inquiry card.

DYNAMIC SHOCK TESTER

New Model HY-600 of maker's Hyge Shock Tester provides four times greater thrust force than previ-



ous models: up to 40,000 lbs. Shock pulses are accurately controllable for both waveform and acceleration and deceleration level. Acceleration-time waveforms are free from high-frequency transients.—*Rochester Div., Consolidated Electrodynamic Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **368** on inquiry card.

ABRASION TESTER FOR WIRE INSULATION

New Abraser and special wire abrasion head provide a scientific test for evaluating wear of wire insulation.

Rotary rub-wear of dual abrading wheels produces a criss-cross abrading action, attacking specimen at all angles throughout a continuous 360° rotation.—*Taber Instrument Corp., Section 75, N. Tonawanda, N. Y.*

For more information circle **369** on inquiry card.

HI-LO TEMPERATURE OVEN

New Model 8108 features automatic temperature control to 0.5 C° from 0°C to 60°C, with forced-air circulation assuring uniformity within 1 C° throughout chamber. Refrigerator motor is hermetically sealed and compressor and fan motor permanently lubricated.—*Electric Hotpack Co., 5065 Cottman St., Philadelphia 35, Pa.*

For more information circle **370** on inquiry card.

VIBRATION EXCITER

New Model C10VB provides a force output as high as 1750 lb and has a frequency range of 5 to 5000 cps, thus is the highest-frequency electrodynamic vibration exciter in its force range. It can operate continuously at rated force under severe environmental-chamber conditions: altitude to

IN THE F-101

Statham transducers gathered pressure and acceleration data in McDonnell Aircraft Corporation's program to prove out the aerodynamic design and structural design.

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Accelerometers • Load Cells
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Catalog, complete with prices, available upon request.

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LOS ANGELES 64, CALIFORNIA

For more information circle **93** on inquiry card.

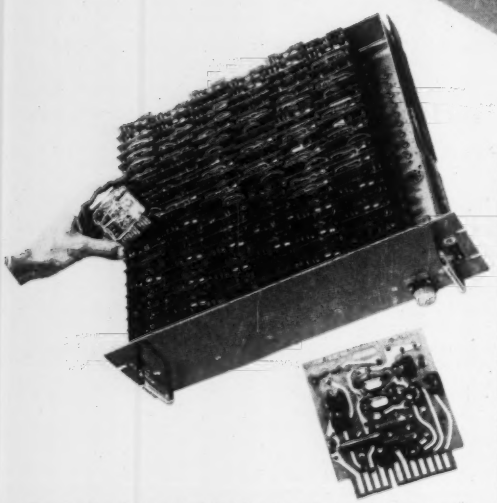
NEW EECO

Silicon

TRANSISTOR PLUG-INS

for extremely reliable ground and airborne equipment

−40° C to +100° C



This is the first **complete line** of transistorized systems components offering hermetically sealed **silicon** semiconductors and components.

Check these features:

- Operate reliably in ambient temperature range of −40°C to +100°C.
- Smaller, more compact (mounted on 2-7/8" x 2-9/16" x 1/16"-thick epoxyglass); still incorporating more components.
- Power supply requirements ±20 Volts.
- Plug into any standard 12-contact etched-circuit connector.
- All plug-in contacts rhodium-plated for long life and trouble-free service.
- Complete supply of compatible systems hardware.

CIRCUITS: The complete line of EECO **Silicon** Transistor Plug-in circuits includes:

FLIP-FLOPS
ONE SHOTS
NEON DRIVERS
RESET GENERATORS
DIODE LOGICS
EMITTER FOLLOWERS
SQUARING CIRCUITS
LINEAR AMPLIFIERS
BLOCKING OSCILLATORS
and many others.

NEW EECO RUGGEDIZED STANDARD-SERIES PLUG-INS

The full line of tested and proven circuits available in EECO's Standard-Series Plug-ins has been ruggedized for even greater reliability and more efficient performance.

Each unit now incorporates the IERC Shield to:

- Protect tube from vibration and shock.
- Dissipate heat more effectively.
- Ensure longer tube life with cooler, more efficient operation.
- Provide even greater electrical shielding.

New mechanical construction and design assures full protection to critical components against stress or tension.

All ruggedized units are compatible with EECO Standard-Series hardware and EECO Systems Development Racks.

NEW CIRCUITS include High-Speed Flip-Flops, Oscillators, etc., in both Computer-Series and Standard-Series Plug-ins . . . plus other systems building blocks: D-C Chopper Stabilized Amplifiers, Power Supplies and Compatible Accessories, Systems Development Racks, Systems Components. Detailed information available in Catalog No. 856-A.

AVAILABLE SOON: New EECO Germanium Transistor Plug-ins. These EECO units will comprise a complete line of transistorized systems components, including a full complement of circuits (One Shots, Flip-Flops, Linear Amplifiers, Pulse Amplifiers, "And" Gates, "Or" Gates, and many others) as well as compatible systems hardware.

ENGINEERED ELECTRONICS COMPANY
a subsidiary of
Electronic Engineering Company of California
506 EAST FIRST STREET · SANTA ANA, CALIFORNIA

For more information circle **94** on inquiry card.

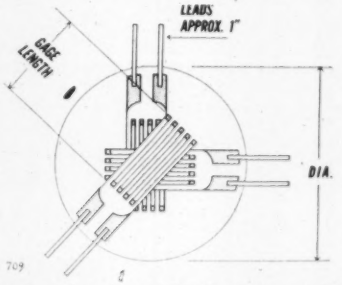
NEW INSTRUMENTS

125,000 ft, humidity to 95%, temperature from −100°F to 300°F with temperature barrier.—*MB Mfg. Co., P.O. Box* 1825, *New Haven* 8, *Conn.*

For more information circle **371** on inquiry card.

FOIL GAGE ROSETTE

New type of supersensitive SR-4 strain gage comprises three single-element foil gages individually insul-



ated and mounted in Bakelite at 45° to one another. Made in ½" and ¼" sizes, exhibit greater accuracy and sensitivity, higher resistance to fatigue and lower hysteresis than familiar wire-filament strain gages.—*Electronics and Instrumentation Div., Baldwin-Lima-Hamilton Corp., Box* 72, *Waltham, Mass.*

For more information circle **372** on inquiry card.

ANGULAR OSCILLATING TABLE

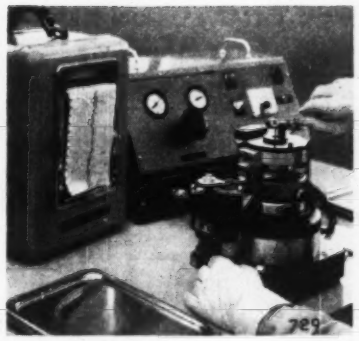
New Model B386 Angular Oscillating Table generates a precise sinoidal function, utilizes a unique ver-

sion of a conical crank mechanism; has an adjustable angular excursion up to ±15° and a continuously-variable frequency range from 0.02 to 3 cps in low range and from 0.2 to 30 cps in high range. Deadweight payload is 100 lb and dynamic payload limit is 750 in-lb.—*Genisco, Inc.,* 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **373** on inquiry card.

BEARING TORQUE TESTER

New automatic torque tester for instrument ball bearings permits from 27 to 50 bearing inspections per

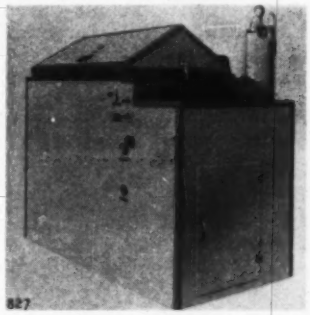


hour at high sensitivity levels. A photoelectric recorder autographs the performance of each bearing. Instrument meets test requirements of MIL-STD-206, comes complete with control cabinet, recorder, spare parts, tool kit, bearing adapters, and instruction manual.—*The Fafnir Bearing Co., New Britain, Conn.*

For more information circle **374** on inquiry card.

FOG TEST CHAMBERS

Newly redesigned Salt Spray Fog Test Cabinets to meet government specs use a thermostatically-controlled

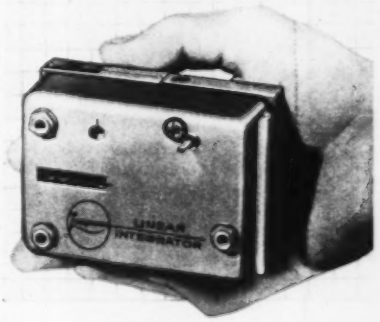


radiant heating blanket for temperature control to "within ½ degree" and to minimize warm-up time.—*Development Engineering Co., 9 Cross St., Norwalk, Conn.*

For more information circle **375** on inquiry card.

automatic flow computation

BY LIBRASCOPE



MODEL 25

Computing Linear Integrator

. . . is designed for temperature recording, averaging and area computation in gas analysis procedures. Providing a fast, accurate and a continuously integrated total of data as it is being recorded, the Librascope Model 25 can be installed on any device having shaft rotation or displacement as an output.

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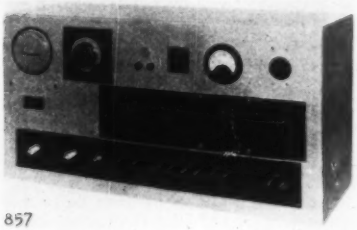
For more information circle **95** on inquiry card.

ELECTRICAL TESTING

CURRENT TRANSFORMER TESTING EQUIPMENT

New Uniload Current Transformer Testing Equipment includes maker's Precision Multirange Current Trans-



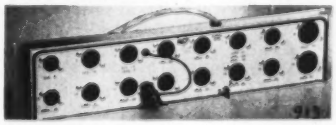
857

former for use as standard of comparison. Two auxiliary instruments are required: a suitable ammeter and a low-capacity zero-center wattmeter. Type AT-6 Knopp Uniload Current Transformer is for calibrating current transformers of ratings from 5 to 1500 amp.—*Knopp Inc., 1307-66th St., Oakland 8, Calif.*

For more information circle **376** on inquiry card.

TUBE TESTER PANEL

New Model 510 Accessory Socket Panel extends use of Model 500 Dyna-Quick Dynamic Mutual Conductance



Tube Tester by providing 50% more sockets for old and new tube types; comes ready to install and connect.—*B & K Mfg. Co., 372 N. Southport Ave., Chicago 13, Ill.*

For more information circle **377** on inquiry card.

TRANSISTOR TESTING SET

New Model 102 is designed for rapid measurement of I_{CO}, base-collector breakdown voltage and current gain (both large and small signal). Measurements are made at normal operating current and voltage levels; base currents up to 50 ma, collector currents up to 2 amp and collector voltage up to 28 v.—*Strand Engineering Co., 1354 N. Main St., Ann Arbor, Mich.*

For more information circle **378** on inquiry card.

COIL & CAPACITOR TESTER

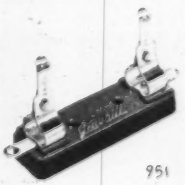
950

New improved Model 51 checks battery ignition coils, magneto coils and armatures, and ignition capacitors.—*Graham Research, Inc., 666 - 22 Ave., N. E., Minneapolis, Minn.*

For more information circle **379** on inquiry card.

TEST CLIP ADAPTER

New screw mount test clip adapter for fixed panel mounting has solder terminals at each end, and holes for No. 8 screws on ¾" centers; greatly simplifies testing of resistors, capacitors, and similar pig-tail components.—*Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.*



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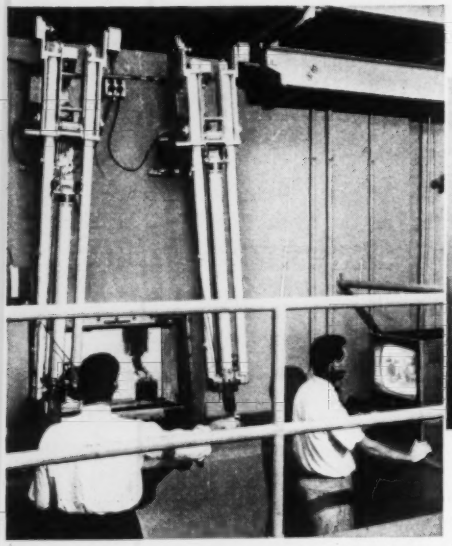
For more information circle **380** on inquiry card.

Diamond

"UtiliVue"
(WIRED TELEVISION)

IMPROVES HANDLING
of RADIOACTIVE MATERIAL



Mechanical manipulators are watched, close-up and from the side, by Diamond "UtiliVue". Personnel are fully protected from radiation.

Diamond "UtiliVue" camera mounted in radioactive cell has remote focus and three-position remote control lens turret.

AT NUCLEAR SYSTEMS
a division of the Budd Company
Philadelphia, Pa.

This is one of many installations where a Diamond "UtiliVue" permits close watch of operations with complete safety to personnel. The Diamond ITV Camera here is an invaluable ally to the viewing window as the mechanical manipulators handle radioactive material. It provides important depth perception and permits a close-up view for fine detail.

You may never handle radioactive material, but Diamond ITV can save you money and improve a wide variety of operations. Investigate today. Call your nearest Graybar Office or use the coupon below.

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Title_____
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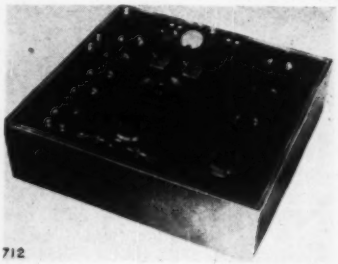
Address_____

For more information circle **96** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

LABORATORY STANDARD INDUCTANCE BRIDGE

New Sullivan-Griffiths Type AC 1100 Direct-Reading Inductance Bridge is a standard, with accuracy



712

of 0.1% "guaranteed over many years despite wide temperature variations." It measures inductances from 1 microhenry to 100 henries.—*Department K30, British Industries Corp., Port Washington, N. Y.*

For more information circle **381** on inquiry card.

TRUE RMS VOLTMETER

New Model 14A True RMS Voltmeter utilizes a thermo-milliammeter, a transistor amplifier, and a coaxial

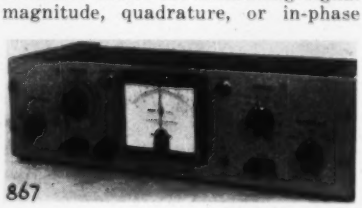
823

input attenuator to provide full-scale indication for input voltages from 0.5 mv to 200 volts. Accurate readings from 15 cps to 500 kc. Voltage differences as small as 0.5% can be detected.—*Electra Div., Consolidated Electrodynamics Corp., 325 N. Altadena Drive, Pasadena, Calif.*

For more information circle **382** on inquiry card.

PHASE ANGLE VOLTMETER

New Model 201 BR dual-filter multifunctional Phase Angle Voltmeter, available in portable and rack versions, provides 10-microvolt sensitivity as a phase-sensitive null indicator, with less than 5 microvolts of noise. Harmonic rejection exceeds 55 db, when used with internal filters. Full-scale voltage ranges 1 mv to 300 mv in twelve scales for measuring signal magnitude, quadrature, or in-phase



867

component of a signal. Angular measurement to 0.1°; substitution measurements of phase angle using built-in calibrated phase shifter.—*Instrumentation Div., North Atlantic Industries, Inc., 603 Main St., Westbury, L. I., N. Y.*

For more information circle **383** on inquiry card.

DC DIGITAL VOLTMETER

New Model 401 features an entirely new single-plane wide-angle readout with non-overlapping characters of

exceptional sharpness and clarity, automatic polarity indication and automatic decimal placement; automatic continuous calibration against an internal standard cell; 0.75-second average reading time.—*Kin Tel, 5725 Kearny Villa Rd., San Diego 11, Calif.*

For more information circle **384** on inquiry card.

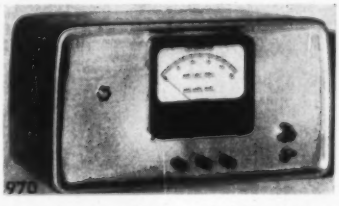
VOLT-OHM-AMMETER

New 29-range Model 8 Universal Avometer is said to provide "long-term accuracy and dependability previously unattainable in portable multimeters." Each instrument is hand-calibrated. When set on a dc range and connected to an ac source, no reading will result and instrument cannot be damaged; it can be used to determine whether ac or dc is present in a circuit. Individual zero-setting voltage dividers for each resistance range permit switching between ranges without rezeroing.—*Dept. K3, British Industries Corp., 80 Shore Road, Port Washington, N. Y.*

For more information circle **385** on inquiry card.

VOLTAGE RATE-OF-CHANGE INDICATOR

New Deltameter, for continuous indication of rates-of-change at values too slow or too small for conventional

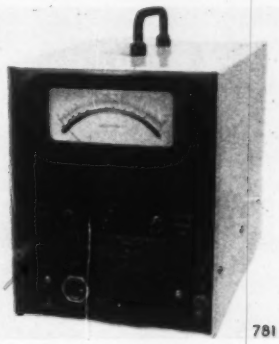


measuring methods, yields output signal representing millivolts per seconds^2 visually displayed and/or fed to a recorder or to a controlled system. Input voltage can represent temperature, pH, or other variable. In operation, Deltameter samples a voltage pulse at time T and stores it. At time $T+\Delta T$, a second sample is compared with the first. ΔT is precisely controlled. Output is dE/dt.—*Miljan, Inc., P. O. Box 396, Paramount, Calif.*

For more information circle **386** on inquiry card.

ELECTROMETER-MEGOHMMETER

New Type 8 Electrometer-Megohmmeter measures resistances from 5 megohms to 5 × 10^{5} megohms; also

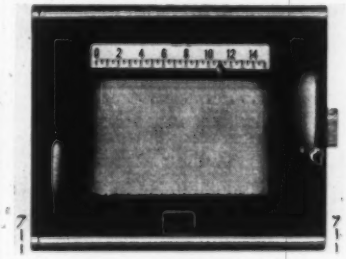


serves as a general-use electrometer for measuring voltages up to 10 v and currents from 10^{-4} to 10^{-13} amp; features single-knob range selection, control of input grounding and resistor charging by a single switch, and guarding of all input circuit insulators.—*Dr. Walter N. Trump, 516 S. Vermont, Columbus, Kansas.*

For more information circle **387** on inquiry card.

X-Y RECORDER

New Electronic Dynamaster X-Y recorder autographs relationship of one measured variable to another on



a 12" strip chart; is available in pen speeds to 0.4 sec for full-scale traverse to follow rapidly-changing variables. Standard accuracy is 0.25%.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **388** on inquiry card.

X-Y PLOTTER

New ER-90, completely redesigned and repackaged, has input sensitivity as high as 1 mv/in; features full chart visibility and slip-on pen plotting on

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For more information circle **97** on inquiry card.

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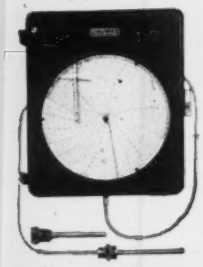

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

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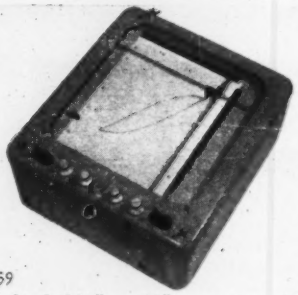
For more information circle **98** on inquiry card.

NEW INSTRUMENTS



859

standard 8½" x 11" paper; repeatability better than 0.05%.—*Mandrel Industrial Instruments, 5134 Glenmont Drive, Houston, Texas.*

For more information circle **389** on inquiry card.

AC VOLTMETER

New Model 15A AC portable electronic multirange ac voltmeter designed to bridge balanced circuits covers from 1 mv to 300 vac full-

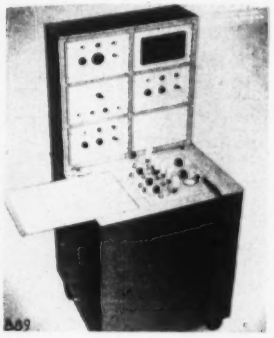
926

scale within frequency range of 30 cps to 300 kc; is powered by four 4-v mercury cells. Transistor circuitry permits instant operation.—*Consolidated Electrodynamics Corp., 325 N. Altadena Drive, Pasadena, Calif.*

For more information circle **390** on inquiry card.

OSCILLOGRAPH

New low-cost sectionalized multichannel oscillograph enables user to intermingle electrical, pneumatic and



889

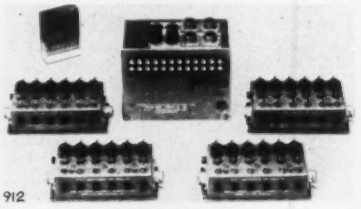
mechanically-actuated pen writers on same chassis. This building-block system, and a wide selection of plug-in amplifiers and transducers, provide unusual flexibility.—*C. H. Stoelting Co., 424 N. Homan Ave., Chicago 24, Ill.*

For more information circle **391** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

AUTOMATIC CALIBRATING BRIDGE-BALANCE SYSTEM

New subminiature system for use with resistance type pickups controls, balances and automatically calibrates



912

up to 24 pickup channels; comprises four new Model 6-104 bridge balance and calibrating units, used alone for manual calibration or in groups with new subminiature Model 50B Automatic Calibrator and Control.—*B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa.*

For more information circle **392** on inquiry card.

MIRROR GALVANOMETER

New Hilger & Watts Galvoscale self-contained mirror galvanometer offers sensitivity as high as 2000 mm/ua on brightly-lit built-in scale, fully legible under normal room illumination. Scale length is equivalent

to an optical lever nearly 7 ft long. Linear and logarithmic scales available.—*Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.*

For more information circle **393** on inquiry card.

AC NULL INDICATOR

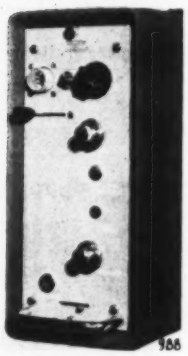
780

New Model 125-1 Null Meter greatly simplifies most ac null measurements. Without range switching, operator can continuously observe signal voltage decreases below 1 volt.—*Trio Laboratories, Inc., 4025 Merrick Rd., Seaford, N. Y.*

For more information circle **394** on inquiry card.

AMPLIFIERS

INSTRUMENT AMPLIFIER

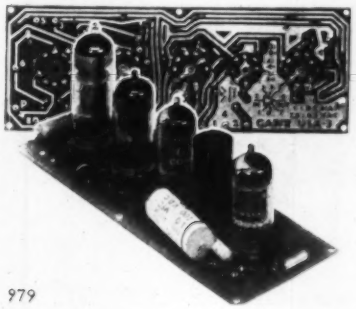


New Model 450-1800A true differential dc amplifier with position and smooth gain controls features low noise, low drift, high gain; is designed to drive an optical galvanometer, oscilloscope, or tape recorder. — *Sanborn Co., Industrial Div.*, 175 *Wyman St., Waltham* 54, *Mass.*

For more information circle **395** on inquiry card.

STABILIZED AMPLIFIER

New Model USA-3 has such a high inherent gain that feedback circuitry alone determines loop gain. Since user



979

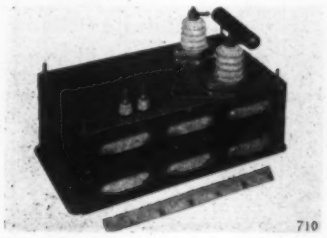
selects this circuitry, he can obtain exactly output characteristic best suited to his particular application. Distortion, noise, and drift are negligible in most applications. It can use nearly any conventional feedback circuit and yet be dynamically stable. Thus it is a truly universal amplifier. —*George A. Philbrick Researches, Inc.*, 230 *Congress St., Boston* 10, *Mass.*

For more information circle **396** on inquiry card.

POWER SUPPLIES

HV DC POWER SUPPLIES

New Series 9000 Hi-Sel feature air insulation for minimum weight and selenium rectifiers for small



710

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	0-200mm Hg. 0-410mm Hg.
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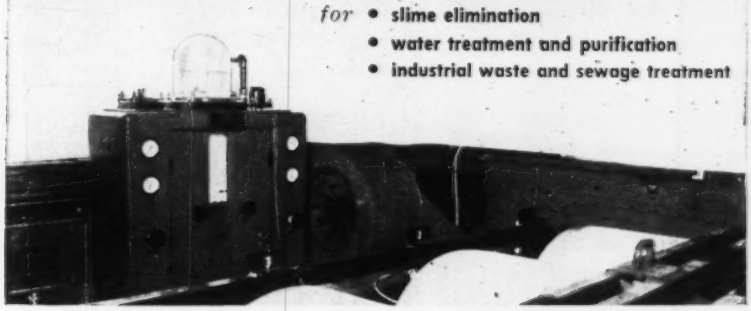

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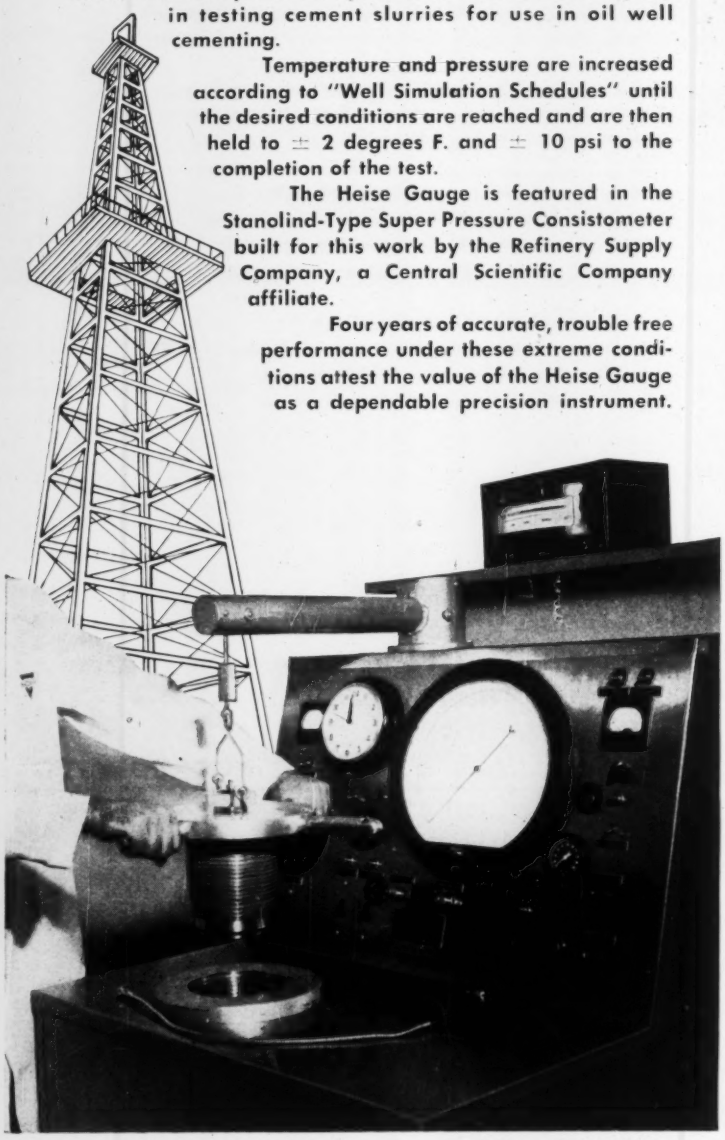

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For more information circle **100** on inquiry card.

size; are available with maximum outputs from 5 to 15 kv, 2.5 and 5 ma; low ripple in all current ratings and good dynamic load regulation.—*Beta Electric Div., Sorensen & Co., Inc., 333 E. 103rd St., New York 29, N. Y.*

For more information circle **397** on inquiry card.

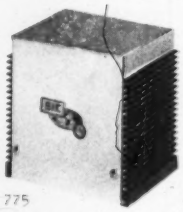
TRANSISTOR SAFETY SUPPLY

899

New Safety Model SS-2 low-cost dc lab power supply, designed especially for use with transistors, provides instantaneous positive protection against overload, current creep, overheating, short circuits, etc.; delivers 6, 12, 18, 24, and 30 v with limiting current ranges of 1, 3, 10 and 30 ma.—*Western Apparatus Co., 2001 Greenleaf St., Evanston, Ill.*

For more information circle **398** on inquiry card.

CONVERTERS FOR HV DC


775

New TPC Series Transistorized Power Converters deliver high-voltage dc from a low-voltage dc supply. Shown: TPC-2 designed for 12-v input and 150-v 400-ma or 300-v 200-ma output. Efficiency better than 75% hence good in replacing dynamotors and vibrator type power supplies.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Texas.*

For more information circle **399** on inquiry card.

ROTARY CONVERTER

New large dc-to-ac converter features heavy-duty construction, drip-proof ventilation and marine specs for service under the most exacting conditions. Available for 32, 48, 64, 115 and 230 vdc inputs with ac outputs of 115 or 230 v, 50 or 60 cps, single- or 3-phase; output capacities 1250, 1500 and 2000 watts.—*Carter Motor Co., 2711A W. George St., Chicago 18, Ill.*

For more information circle **400** on inquiry card.

MOTOR GENERATORS

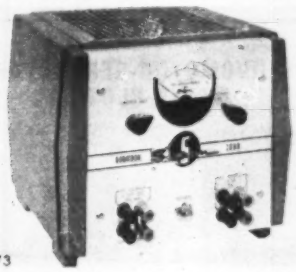
New M-G sets: (*Left*) Remote-control variable-frequency set; generator rating 5 kw, 3 phase; frequency in-

crease or decrease between 360 and 440 cps accomplished by pushing fast or slow push button. Automatic frequency and voltage regulations are both high-precision. (*Right*) New 15-kw frequency-changing set with 220/440-volt 3-phase 60-cps input and 400-cps output.—*Kato Engineering Co., 1415 First Ave., Mankato, Minn.*

For more information circle **401** on inquiry card.

300-VDC SUPPLY

New B-Nobatron Model 300B wide-range B-power supply utilizes printed circuits; features parallel or series



773

operation, external sensing, excellent regulations and stability, and low ripple. It also provides unregulated 6.3 or 12.6 vac.—*Sorenson & Co., Richards Ave., So. Norwalk, Conn.*

For more information circle **402** on inquiry card.

RESISTORS

HIGH-TEMP TRIMMER

New Model 242 High Temperature Trimpot features total resistance range 100 to 100,000 ohms; end setting 0 to 0.1%; operating temperature range −65°C to 300°C; humidity MIL-STD-202, Method 106, 10 days; power rating 2 watts at 100°C; standard size ¼" x ⅜" x ¼"; 25-turn adjustment with self-locking screwdriver-slotted shaft, wiper assembly that idles at either end of travel to prevent damage from forced adjustments.—*Trimpot Div., Bourns Laboratories, Inc., 6135 Magnolia Ave., Riverside, Calif.*

For more information circle **403** on inquiry card.

COMMERCIAL VDR LINE

New Trimit line of lead-screw-actuated balancing voltage-dividing resistors, available to commercial in-

809

strument and equipment manufacturers, features subminiature size, 25-turn self-locking screwdriver adjustment, and space-saving rectangular shape.—*Bourns Laboratories, Inc., P.O. Box 2112, Riverside, Calif.*

For more information circle **404** on inquiry card.

ELECTRICAL COMPONENTS

TWIN POWER TRIODE

New Type 6528 high-current medium-mu twin triode, developed specifically for series regulator service in dc power supply units, features high reliability and rugged construction for heavy-duty applications.—*Tung-Sol Electric Inc., 95 Eighth Ave., Newark 4, N. J.*

For more information circle **405** on inquiry card.

MIDGET TRANSFORMER

New Teenyformer, said to be the world's smallest transformer, is completely hidden by a lead-pencil eraser. Dimensions 0.203" x 0.297" x 0.297". Designed for transistor applications.—*Gramer-Haldorson Transformer Corp., 2734 N. Pulaski Rd., Chicago 39, Ill.*

For more information circle **406** on inquiry card.

AUDIOFREQUENCY DELAY LINE

932

New Fixed Delay Line for use as a component or as test equipment in advanced computer and radar systems has a 3000 usec delay ±5%; 3-db bandwidth of 5 kc; can be tapped as required; meets all applicable MIL specs.—*ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.*

For more information circle **407** on inquiry card.

HARMONIC FILTERS

786

New Series 520 low-cost Twin-T filters for hum and harmonic elimination feature hermetic sealing, small size, stability; are available with any null frequency and a variety of impedance levels. Guaranteed null attenuation is 50 db or better.—*White Instrument Laboratories, Box 9006, Austin 17, Texas.*

For more information circle **408** on inquiry card.

RUGGEDIZED PLUG-INS

New ruggedized plug-ins meet MIL-E-5272A shock, vibration and temperature tests. Series is said to

727

Rugged XY® Deca Switch

for your selecting and control operations

This direct-drive impulse-controlled stepping switch (reset type) is designed to perform control and selecting functions in industrial and communication applications.

The lightweight Deca Switch offers exceptional reliability and compact ruggedness, plus these added features:

- positive stepping action with special locking device to eliminate bounce of wipers and off-normal contacts when the switch returns to the home position;
- 4 banks of 11 contacts each;
- such time-proven XY advantages as dust-free vertical wire banks, bifurcated wipers, dependable release magnet mechanism, and long-wearing, case-hardened working parts with Parco-Lubrite rust-resistant, oil-retaining finish;
- fast operate and release time.

You can order XY Deca Switches in a wide variety of off normal and release magnet spring combinations to suit your specific requirements. Compact and light, the switches are 4¾" long, 4" wide, 1½" high and weigh 20¼ ounces.

Complete technical details are contained in Bulletin T-5001, available on request.

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be "complete"; includes cathode followers, pulse gates, squaring circuits, dc amplifiers, one-shots, flip-flops, gates, multivibrators, pentagrids, amplifiers, phantastrons, voltage regulators, and others. Custom circuits are readily built in: the only packaging information needed is circuit schematic with parts description.—*Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.*

For more information circle **409** on inquiry card.

TRANSISTORS

Two new transistors: 2N274 germanium *p-n-p* alloy-type transistor embodying "drift" principle operates at frequencies from standard AM band well up into short-wave bands, features high input circuit efficiency. ★2N404, germanium *p-n-p* alloy type junction transistor was designed for low-level medium-speed on-off control circuits.—*Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.*

For more information circle **410** on inquiry card.

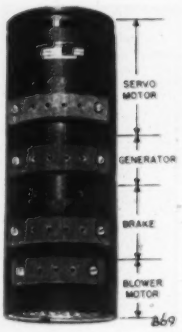
ELECTROMECHANICAL COMPONENTS

MULTI-FUNCTION SYNCHROS

New "3SYN" synchros operate from −55°C to 140°C, are available in Frame Size 23; offer 3-in-1 versatility: (1) as a torque receiver twice the receiver accuracy, one-half the damping time and twice the torque gradient of Mil synchro; (2) as a control transmitter better regulation with less input current, and 3-minute accuracy surpasses 8-min Mil synchro; (3) as a torque transmitter twice the torque gradient and more than twice the electrical accuracy of Mil synchros.—*Norden-Ketay Corp., Commerce Road, Stamford, Conn.*

For more information circle **411** on inquiry card.

SERVOMOTOR-GENERATOR-BRAKE-BLOWER

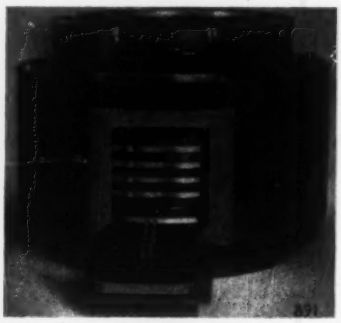


New Type 23-MTG-6327-01 combines a size 23 $\frac{1}{15}$th hp at 6000 rpm servomotor; a damping tach generator with output of 1.5 v per 1000 rpm nominal, null voltage of 0.150, and 2% linearity up to 6000 rpm; 28 vdc brake; and a blower for cooling entire unit. Available in any desired combination of its components. Overall dimensions 8.100" by 2.88".—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **413** on inquiry card.

SLIP RING ASSEMBLY

New slip ring assembly, originally made for checking strain gage readings aboard ships, finds many applications, owing to large rings and brushes which will withstand power circuits. Combination of silver-graphite brushes and coin silver rings assures extremely accurate readings.—*Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio.*



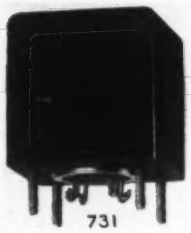
For more information circle **412** on inquiry card.

DEVELOPMENT MOTOR KIT

New Systems Development Motor Kit makes it possible to determine proper motor required for control applications; obviates need of purchasing sample motors; contains all necessary motors, motor components, and gear reduction units to assemble 32 different servo, torque or synchronous motors (with or without integral gear reduction units) and a manual. Special discount to educational institutions.—*Holtzer-Cabot Motor Div., 125 Amory St., Boston, Mass.*

For more information circle **414** on inquiry card.

SERVO SYSTEM COMPONENTS


731

New Models QR-400 and QR-60 Quadrature Rejectors eliminate troublesome problem of quadrature in ac servos (iron saturation in high-gain amplifiers). Transistor or tube interstage unit passes signal with 6 db maximum attenuation while rejecting quadrature 40 db minimum. Temperature range —55°C to 100° C.—*Feedback Controls, Inc., 899 Main St., Waltham 54, Mass.*

For more information circle **415** on inquiry card.

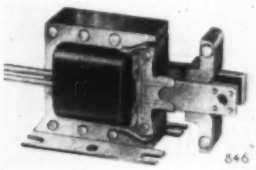
INDUCTION MOTOR

New induction motor for fan and blower drive or general-purpose induction-drive motor applications is 1" dia by about 1½" long; offers unique feature of operating off the 115-v 60-cps line without use of step-down transformers or dropping resistors. It can drive a 3" fan blade at 3200 rpm or a 4" at 2700 rpm with only 6 watts input.—*Eastern Air Devices, Central Ave., Dover, N. H.*

For more information circle **416** on inquiry card.

POWER SOLENOID

New No. 18 A.C. Solenoid has coil winding completely encapsulated in Permaseal thermosetting epoxy.


846

Available for intermittent or continuous duty operation. With ⅛" plunger stroke, solenoids lift up to 11 lb. Stroke is adjustable from 1/32" to 1". —*Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.*

For more information circle **417** on inquiry card.

SWITCHES & RELAYS

INDICATOR SWITCH

New Pan-i-Lite projects less than 1" behind panel, is an integral-push-button bulb-lens assembly designed for quick replacement from front of panel; available in 3, 6, 12, and 28 volts, in blue, red, green, white and yellow. Can be wired as a momentary contact push-button style indicating switch or as a press-to-test indicating light.—*Alden Products Co., Department TS-133, Brockton, Mass.*

For more information circle **418** on inquiry card.

POT LIMIT SWITCH

New pair of rugged snap-action limit switches for attachment to a 1" voltage-dividing resistor features

893

range of angles from 0 to 360°; operating torque at switch action points of 3.5 oz-in (max) and running torque of 0.5 oz-in (max).—*Technology Instrument Corp. of Calif., 7229 Atoll Ave., North Hollywood, Calif.*

For more information circle **419** on inquiry card.

ALTERNATE PULSE RELAY

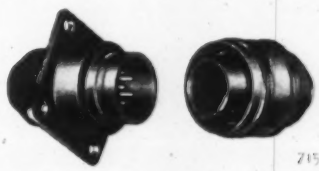
New PC single-coil latching relay selects alternate circuits or alternate circuit modes on successive impulses; employs an armature-driven rocker-type actuator to transfer 1, 2, 3 or 4 dp-dt snap switches; can be operated from ac or dc sources and provides positive transfer on a single 30-millisecond impulse.—*Potter & Brumfield, Inc., Princeton, Ind.*

For more information circle **420** on inquiry card.

CONNECTORS, etc.

QUICK-DISCONNECTS

New "Q" Series quick-disconnect connectors have environmental-resistant features for aircraft service; are

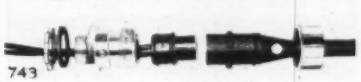

715

available in 3 sizes with 3 shell configurations: QO2 square-flanged receptacle; QH25 hermetically-sealed round-flange; and QO6 straight plug. —*Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.*

For more information circle **421** on inquiry card.

DIRECT-MOUNT CONNECTORS

New Change-outs are novel electrical connectors that mount directly through knock-out or threaded holes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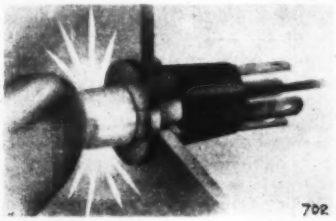
702

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EXPLOSION-PROOF ANNUNCIATORS (Type EXP-4)

Wherever processes or systems in hazardous locations must be monitored with unwavering safety, consider Scam Explosion-Proof Annunciators. These rugged alarms provide a sturdy housing that is approved for Class I, Division I, Group D locations.

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For more information circle **105** on inquiry card.

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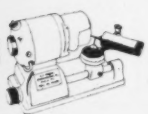

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For more information circle **106** on inquiry card.

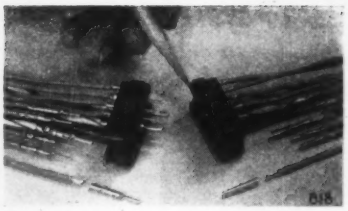
NEW INSTRUMENTS

in wiring boxes, panels and ducts or on small motors and electrically-driven hand tools. Available with 2, 3 or 4 contacts for 8-amp to 20-amp applications at 600 v maximum rating. —*Dep't* O-24, *Joy Mfg. Co., Electrical Products Div.*, 1201 *Macklind Ave. St. Louis* 10, *Mo.*

For more information circle **422** on inquiry card.

SOLDERLESS CONNECTOR

New "Hyfen" solderless multi-lead plug-and-receptacle connector speeds wiring of electronic harnesses; enhances dependability and versatility.



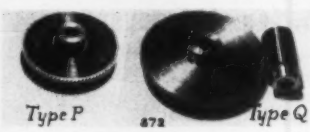
Pins and sockets are crimped to wire ends by single-stroke manual or high-speed automatic tools. Plug and receptacle can be pulled out individually.—*Burndy Corp., Omaton Div., Norwalk, Conn.*

For more information circle **423** on inquiry card.

MECHANICAL COMPONENTS

ANTI-BACKLASH GEARS, WORMS AND WHEELS

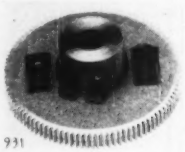
New units added to Type P line make available from stock a complete range of anti-backlash spur gears:



24 to 200 pitches, from ⅛" to ¼", in stainless steel, aluminum and bronze. Completely new Type Q stainless steel worms and bronze wheels.—*PIC Design Corp.*, 477 *Atlantic Ave., East Rockaway, N. Y.*

For more information circle **424** on inquiry card.

ANTI-BACKLASH GEARS



New Dynaco anti-backlash gears feature new design which results in availability of assemblies having a Class II precision fixed gear, a smaller hub diameter with a lower polar moment of inertia, and disassembly of floating member by user if desired. Carried in stock in Precision Class I and Precision Class II from 1" to 2" PD; solid end or clamp type hubs; 3 bore sizes.—*Dynamic Gear Co., Inc.*, 20 *Merrick Rd., Amityville, N. Y.*

For more information circle **425** on inquiry card.

VALVES, ACTUATORS

SOLENOID PILOT VALVES WITH MANUAL ACTUATORS

New feature of solenoid valve-piloted air valves consists of twist-type manual actuators for operating

air cylinder during set up and try-out of the mechanism. Model BVP-1 (single solenoid) and BVP-2 (double solenoid) are full pressure piloted available in ⅛" to ½" sizes.—*Beckett-Harcum Co., Wilmington, Ohio.*

For more information circle **426** on inquiry card.

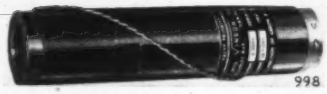
HP SOLENOID VALVES

New high-pressure valves with explosion-proof solenoid are rated for oil and water pressures to 250, 1500, and 3000 psi, and air pressures to 250, 1000, 1500 psi; come in four-way, three-way, shut-off and diverter-flow patterns; feature "Shear-Seal" design which maintains sealing qualities for millions of cycles.—*Barksdale Valves*, 5125 *Alcoa Ave., Los Angeles* 58, *Calif.*

For more information circle **427** on inquiry card.

RELIEF VALVE

New balanced outlet relief valve provides pressure relief where high or variable downstream pressure exist; has no measurable change in crack or flow setting when variations



998

in outlet pressure occur, a desirable feature in aircraft hydraulic systems. Max pressure 4000 psi; temperature range −65°F to 275°F; available in ¼", ⅜" or ½" pipe or tube size.—*Vinson Mfg. Co., 8044 Woodley Ave., Van Nuys, Calif.*

For more information circle **428** on inquiry card.

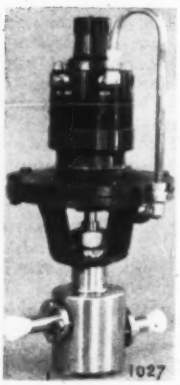
SOLENOID VALVE

907

New Series 2000 two-way stainless steel solenoid valve for corrosive gases and fluids is rated to 6000 psi; designed for use with any media; is a direct-type machined from 316 stainless steel bar-stock; is available in ⅛", ¼", ⅜" and ½" pipe sizes. "Bubble-tight" construction is also available.—*Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.*

For more information circle **429** on inquiry card.

ANTI-CORROSION VALVE



1027

New Model B-2260 for corrosive fluids has its body, stuffing box, integral seat and internal ports machined from a Teflon block and encased in a stainless steel housing. Plug-and-stem likewise Teflon and SS-reinforced. Plugs meet users' specs within range of 0.003 to 1.4 Cv, max rangeability 50 to 1.—*George W. Dahl Co., Inc., 430 High St., Bristol, R. I.*

For more information circle **430** on inquiry card.

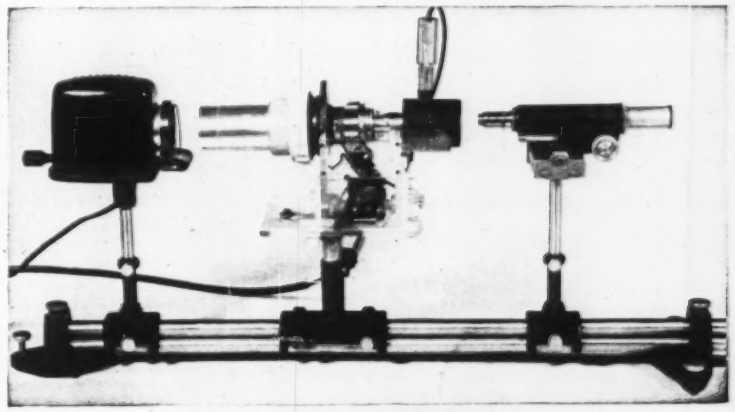
ELECTRIC ACTUATOR

915

New oil-submerged spring-return proportional-type electric motor-operator for dampers, etc., can be mounted in any position. Output shaft is power operated in both directions; maintains position with an internal holding circuit. Spring return drives controlled device to its normal position on a power interruption.—*Barber-Colman Co., 1300 Rock St., Rockford, Ill.*

For more information circle **431** on inquiry card.

A NEW APPROACH TO THE PROBLEMS OF INSTRUMENTATION



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For more information circle **107** on inquiry card.

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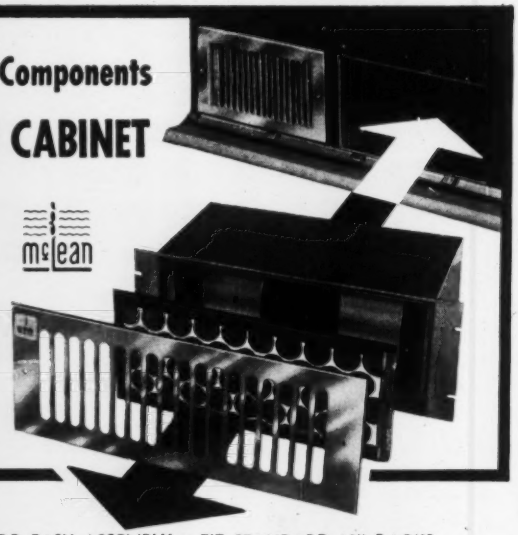

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Models Available for 5¼", 7" and 10½" Panel Heights • Wide Range of Air Deliveries

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Install McLean Fans and Blowers in Computers, Control Systems, etc. They're small, ready to use, packaged units with smart stainless steel grilles and easily replaceable filters. Standard RETMA notching allows mounting on rack without cutting or fitting.

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For more information circle **108** on inquiry card.

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON

HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

A COMPLETE LINE OF HATCHET IRONS BY HEXACON
—Originator and Pioneer

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25H	25	1/8"	$ 6.50
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30H	60	1/4"	6.75
70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
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506 West Clay Ave., Roselle Park, New Jersey

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

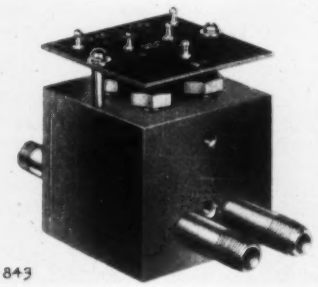
For more information circle **109** on inquiry card.

NEW INSTRUMENTS

MISCELLANEOUS

THERMISTOR THERMAL CONDUCTIVITY CELLS

New Thermistor Thermal Conductivity Cells for gas analysis supplement maker's line of hot-wire sensing



843

elements; feature stability, quick response time, and signal strength.—*Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J.*

For more information circle **432** on inquiry card.

SOLID STATE BATTERY

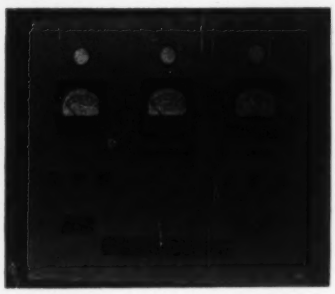
896

New Dynox 95 miniature high-voltage solid-state battery, said to be capable of delivering higher current drains for longer periods of time than other comparable batteries, has a potential of 95 volts; can supply a steady current of 10^{-9} amp for 176,000 hours at 70°F with only a 10% voltage drop, or a flash current of 20 uamp.—*Universal Winding Co., Inc., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.*

For more information circle **433** on inquiry card.

GROUND DETECTOR & ALARM FOR 3-PHASE SYSTEMS

New C5700 Ground Detector has visual and audible alarms that indicate ground faults before they can



do any damage; can be set to discover a line voltage drop as little as 1 v in systems of any voltage rating.—*Principle Research and Development Co., Box 93, Franklin Park, Ill.*

For more information circle **434** on inquiry card.

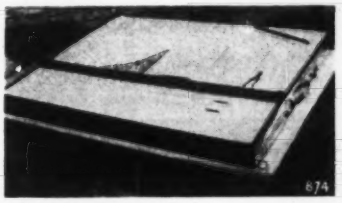
INFRARED LENSES

New Servofrax Meniscus Lenses are single-element infrared lenses designed to have minimal spherical aberration when imaging an object at infinity at a dominant wavelength of 3½ microns. Reasonably good performance extends from 2 to 5 microns.—*Servo Corp. of America, 2020 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **435** on inquiry card.

TRACING BOARD

New larger-size portable tracing unit has usable illuminated area 35¼" x 47¼" (double any previous

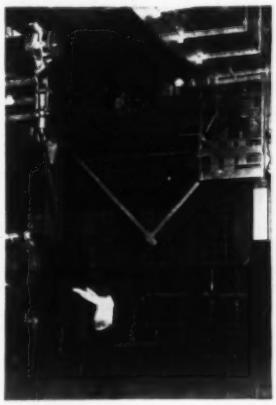


portable unit), cool uniform lighting by four 30-watt fluorescent lamps, built-in straight edge and adjustable back legs.—*Porta-Trace, Inc., 342 Clinton St., Binghamton, N. Y.*

For more information circle **436** on inquiry card.

CRANE SCALE

New Ametron crane scale features reliable non-electronic strain-gage

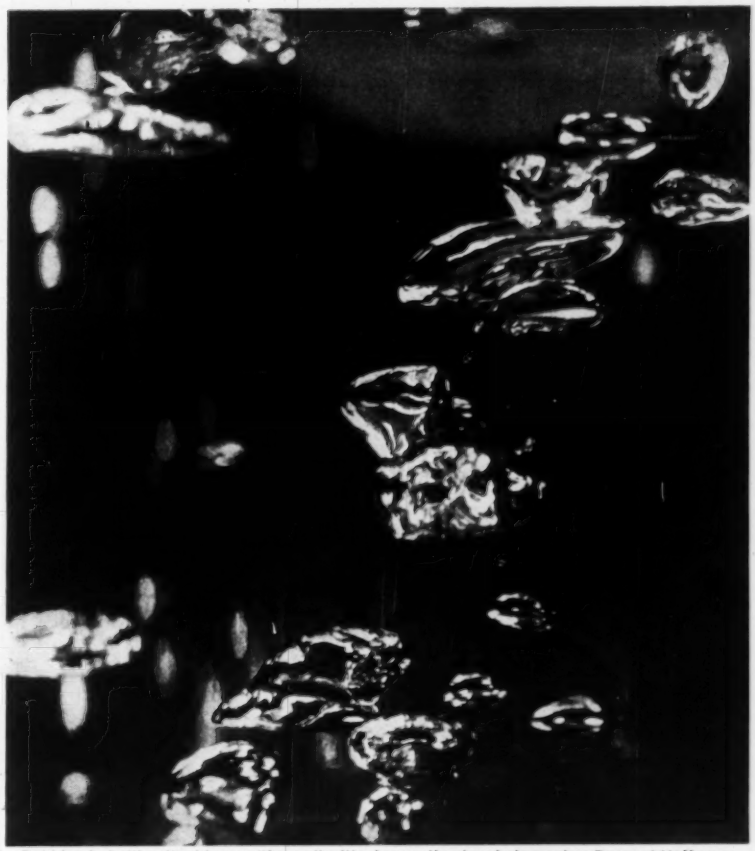


load cell, and remote dial indication or digital display with or without printing on tape, tickets or cards.—*Streeter-Amet Co., Grayslake, Ohio.*

For more information circle **437** on inquiry card.

REMOTELY CONTROLLED 3-LENS TURRET

New Model ARC-4, for maker's television systems, has three remotely-controlled motors for selection of lens,



Bubbles in boiling liquid were "frozen" with stop motion by photographer Bernard Hoffman.

Controlling Temperature in Fluid Engineering

Heat is generally only one part of your problem. Pressure, abrasion or corrosion factors usually must be taken into account, too. So if your past experience offers no precedent, you can look to S. Morgan Smith's specialized engineering leadership for assistance.

A number of materials are available to meet extreme working conditions. Here the broad SMS background combines with specialized valve engineering to help you. Perhaps R-S Butterfly Valves can be applied to control volume and flow at high temperatures. Or, if heat and corrosion make extremely accurate timing and fast, drop-tight closure a tough problem, an SMS Rotovalve could be the answer. Whatever your special processing needs, you can get help in protecting your equipment investment.

There is a full SMS line – standard R-S Butterfly Valves ready for fast assembly and shipment from stock, Rotovalves and Ball Valves. A call to our nearest representative will bring information. Or, write S. Morgan Smith, York, Pa., for data on standard valves or special applications.

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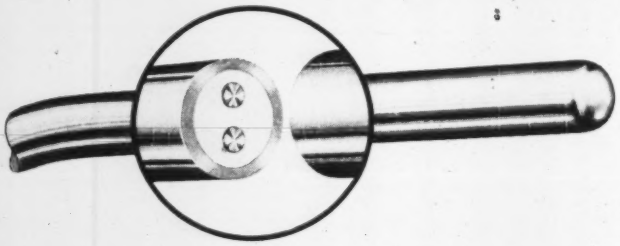
Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

For more information circle **110** on inquiry card.

Longer Thermocouple Life In Atomic Reactors

With T-E Ceramo® Wire Thermocouples



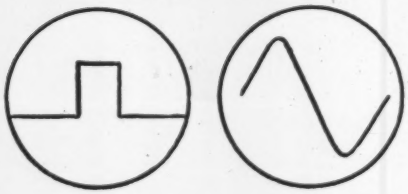
Designed for use under extremely severe conditions, enclosed hot-junction "Ceramo" thermocouples—with ceramic insulated, metal sheathed wire—will outlast comparable standard types many times. And response time is just as fast. Furthermore, both sheathing and insulation can be specially selected for resistance to atomic radiation. Conductors in all standard calibrations and various sheath materials are available for temperatures up to 3000° F. If desired, "Ceramo" thermocouples can be completely pre-tested. Conductors—36 to 12 gage. Overall diameters—1/25" to 7/16".

Write for Bulletin 305F.

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **111** on inquiry card.

TRANSISTORIZED MODULAR FREQUENCY METER



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7 RANGES ... 100 • 300 • 1KC • 3KC • 10KC • 30KC • 100KC

INPUT ..... ¼ Volt to 120 Volts

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MODEL FM-241

$125.00

This Instrument is a ⅓ Module of the TLI Modular Instrumentation System and may be rack mounted with Modular Rack Adapters or stacked on a bench using the Modular Stack Pedestal.

RACK STACK CHART

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54 KINKEL STREET
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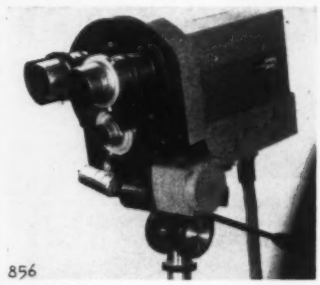
For more information circle **112** on inquiry card.

NEW INSTRUMENTS

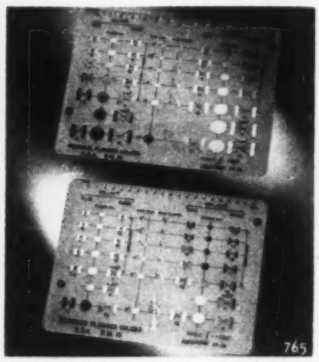


adjustment of lens iris, and focusing by movement of camera relative to lens turret.—*Kin Tel*, 5725 *Kearny Villa Rd., San Diego* 11, *Calif.*

For more information circle **438** on inquiry card.

VALVE TEMPLATES

New No. 88 (⅜" = 1') and No. 89 (¼" = 1') Ferrous Flanged Valve Templates cover B16.10 valves as



recommended by ASA, contain sizes from 2" to 8" pipe diameter in light (125-150-lb) and heavy (250-300-lb) series.—*Rapidesign, Inc., P. O. Box 429, Burbank, Calif.*

For more information circle **439** on inquiry card.

ANGLE-OF-ATTACK PICKUP

New Model 2562 Local Angle of Attack Transducer conforms to MIL-T-25027; comprises a heated split-wedge vane geared to two output synchros. Damping is maintained at 0.5 of critical. Recovery time (63%) at 110 knots 0.075 sec; sensitivity 0.2°

from 90 to 125 knots and 0.1° from 125 knots to Mach 3.0—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **440** on inquiry card.

CORRECTION

Tachometer Calibrator, Servo-Tek Products Co., Hawthorne, N. J. (July issue, p. 1360). Tachometer under test can be driven at speeds up to 5000 rpm (not 500 as printed).

LAST MINUTE ITEMS

Document Laminator. New Ply-On desk-top machine protects and beautifies important business papers by encasing either or both sides with transparent film in a few seconds.—American Photocopy Equipment Co., 75 E. Wacker Dr., Chicago, Ill.

For more information circle **441** on inquiry card.

Ultraviolet Lighted Water Tank. New distilled-water storage tank has ultraviolet light mounted above surface of water, for continuous sterilization of contents.—Barnstead Still & Sterilizer Co., Lanesville Terrace, Boston 31, Mass.

For more information circle **442** on inquiry card.

Bench Ovens. New Stabil-Therm Mechanical Convection Ovens feature horizontal airflow and low-watt-density Eterna heater bank shielded from work chamber by non-radiant panel.—Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

For more information circle **443** on inquiry card.

Terminal Collars with 5 or 6 terminals extend the use of maker's regular coil forms SPC 11 and SPC 12 for more complicated RF circuitry.—Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

For more information circle **444** on inquiry card.

Water Pressure Reducing Valves. New Type E-93 features good gpm capacity and superior regulation; ½" to 2" pipe sizes; well suited for commercial dishwashers, schools, etc.—Cash-Acme, P. O. Box 191, Decatur, Ill.

For more information circle **445** on inquiry card.

Pressure Switch. New Cat. 130 Control for pressures or vacuums of 0.05" to 40" water column, is available in 4", 8" or 10" diaphragm sizes.—Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.

For more information circle **446** on inquiry card.

Perforated Tape Recorder. New Dykor handles paper tape strips or reels; operates at speeds to 750 characters per second, with less than 5 millisecond start or stop time.—Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.

For more information circle **447** on inquiry card.

Dynamometers. Two new traction-type dynamometers with ratings of 0-5,000 and 0-10,000 lb complete mak-

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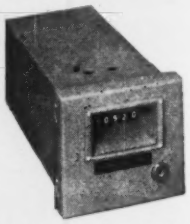

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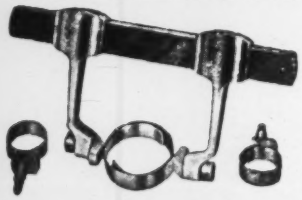

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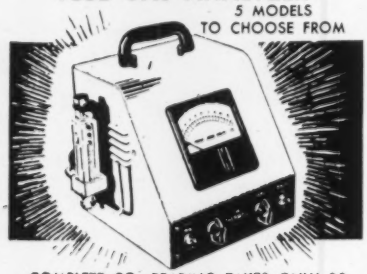

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For more information circle **116** on inquiry card.

NEW INSTRUMENTS

er's line throughout the 0 to 100,000-lb capacity range. Individually calibrated.—W. C. Dillon & Co., 14620 Keswick St., Van Nuys, Calif.

For more information circle **448** on inquiry card.

Timing Lamp Driver. New small (1⅜ x 1¼ x 3⅝") and rugged transistorized driver flashes neon marker lamps to display time-code signals in high-speed cameras, cine-theodolites, etc.—Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

For more information circle **449** on inquiry card.

Transistor Amplifier. New Model 6000 Dec-Amp wide-band low-noise transistor amplifier increases sensitivity ratings of present equipment by a factor of 10 or 100 in audible and ultrasonic ranges; is powered by mercury battery, whence small overall size 3¾ x 2½ x 5½".—EV Instruments, Div. Electro-Voice, Inc., Buchanan, Mich.

For more information circle **450** on inquiry card.

Lab Power Amplifier. New 100-watt Model 6006 incorporating Circlotron output circuit finds many uses as audio and ultrasonic source of power; consists of two 7" rack units, power supply and amplifier, and cables.—EV Instruments, Div. Electro-Voice, Inc., Buchanan, Mich.

For more information circle **451** on inquiry card.

Mag Tape Preamplifier. New Model 6010 is a 3-stage transistor preamplifier for playback use with magnetic tape heads.—EV Instruments, Div. Electro-Voice, Inc., Buchanan, Mich.

For more information circle **452** on inquiry card.

Heavy Duty Magnetizer. New Model 6800 charges permanent magnets (some in their assemblies if certain considerations are met). Instead of bulky short-lived capacitor bank, push-pull ignitrons across a 220-volt line.—EV Instruments, Div. Electro-Voice, Inc., Buchanan, Mich.

For more information circle **453** on inquiry card.

Telephoto. New 80-mm F/2.8 Meyer Primotar Lens for Exakta camera has superlative optical characteristics.—Exakta Camera Co., Bronxville, N. Y.

For more information circle **454** on inquiry card.

Inconel Bellows. Metal bellows of Inconel and Inconel-X meet difficult requirements in high-pressure and high-temperature applications.—Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Knoxville, Tenn.

For more information circle **455** on inquiry card.

Ink Photometer rapidly measures printed areas on maps, cartons, bags, etc.; also any combination of irregular areas that provide sufficient photographic contrast, as in etching of circuits.—Gardner Laboratory Inc., P.O. Box 5728, Bethesda 14, Md.

For more information circle **456** on inquiry card.

Multiple Receiver Unit. New MRU-2, capable of selecting and testing up to ten different frequency tone signals, provides both pilot light indi-

cation and display of measured value. —Hammarlund Mfg. Co., 460 W. 34th St., New York 1, N. Y.

For more information circle **457** on inquiry card.

Single-turn VDR. New Series 5000 Potentiometers are ½" high-temperature stainless-steel units with power rating above 5,000 ohms of 2.5 watts at 60°C derating to 1 watt at 150°C; range 500 to 70,000 ohms.—Helipot Corp., Newport Beach, Calif.

For more information circle **458** on inquiry card.

3-turn VDR. New 1 13/32"-dia Model 9303 Potentiometer for servo mounting features exceptional stability, with 0.25% standard independent linearity and minimum noise characteristics. Rating 3 watts at 40°C. Up to 14 taps.—Helipot Corp., Newport Beach, Calif.

For more information circle **459** on inquiry card.

Circular VDR. New all-metal pressure-sealed circular potentiometer, available in single or dual units, features temperature range from −65°F to 257°F (higher on special order), vibration to 10 G, shock to 30 G, linearity 0.5%.—Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.

For more information circle **460** on inquiry card.

Transistor Checker. New Model 29 measures directly current gain in two ranges 0-250 and 0-1000 and cut-off current I_{CO}.—Instant Circuits Div., Alfred W. Barber Labs., 32-44 Francis Lewis Blvd., Flushing 58, N. Y.

For more information circle **461** on inquiry card.

Power Rectifiers. New 500-amp germanium power rectifier junctions for application to heavy-duty electromechanical, metal-refining, etc., provide efficiency of 98.9%. Cast aluminum airfoil housing measures only 6" x 6" x 4-5/32".—International Rectifier, Inc., El Segundo, Calif.

For more information circle **462** on inquiry card.

Electromagnet features aluminum foil coils and water cooling; develops a field, uniform within 5%, of 10,000 gauss at a pole spacing of 4"; pole gap adjustable from 0 to 12".—Jobbins Electronics, 771 Hamilton Ave., Menlo Park, Calif.

For more information circle **463** on inquiry card.

Transparent Plug-in Enclosures. New PE Series, in clear and colored plastic, protect electronic assemblies from dust, dirt and tampering; have standard RETMA 8- and 11-pin bases; standard size 1⅜ x 1⅜ x 2⅛" high. —Line Electric Co., 271 S. 6th St., Newark 3, N. J.

For more information circle **464** on inquiry card.

Capacitors. New Tan-Sol Type TAS solid electrolyte tantalum capacitors can be used under severe environmental operating conditions; are of axial lead construction, with hermetic glass-to-metal end seals.—P. R. Mallory & Co., Inc., Indianapolis, Ind.

For more information circle **465** on inquiry card.

Motor Start Capacitors with a unique built-in bleeded resistor, feature new design which leaves termi-

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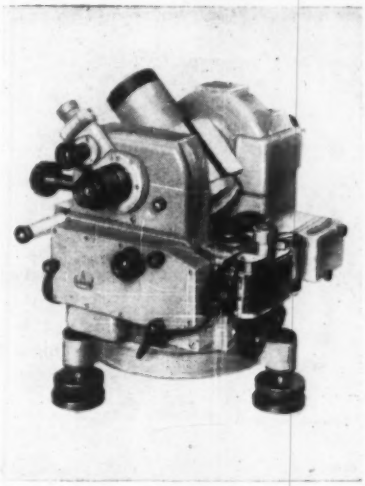

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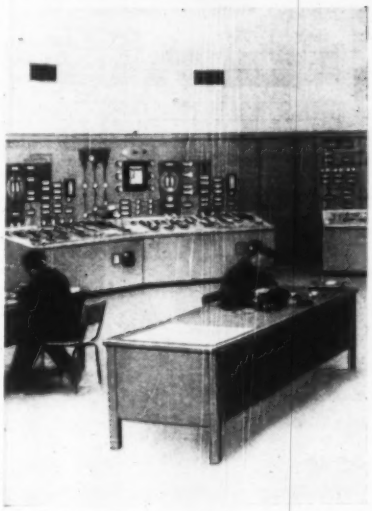

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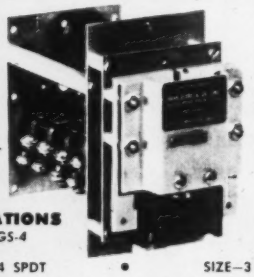

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NEW INSTRUMENTS

nals completely free of any obstruction.—P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.
For more information circle **466** on inquiry card.

Small Rack Cooler. New Model 1H300 is a rack-mounted centrifugal-blower-type package, 5¼" high with 9½" panel width (2 to a regular 19" rack if required), large permanent type filter and beautiful stainless steel grille.—McLean Engineering Labs., P. O. Box 228, Princeton, N. J.
For more information circle **467** on inquiry card.

Tunable Miniature RF and IF Inductors & Transformers for instrumentation, missile, and aircraft applications, provide stability, high Q, shock and vibration resistance. Double-tuned transformers are 1⅛" cube; inductors ¾" dia by 1⅛" long.—Moore Associates, 2628 Spring St., Redwood City, Calif.
For more information circle **468** on inquiry card.

Motor-tach Generator. New Type 15-MTG-6276-02 is a 28-vdc PM motor driving a tach generator. TG has unusually wide frequency range from 380 to 1760 cps at 115 vac; meets MIL-E-5272.—John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.
For more information circle **469** on inquiry card.

Audio Sweep Frequency Generator. New Pandux quickly determines behavior of audio and other alternating electrical apparatus with respect to frequency and associated phenomena. Signal from generator scans from 80 to 20,000 cps; sweep frequency is covered by 20 signal pulses per second, pattern frequency 10 times per second.—Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.
For more information circle **470** on inquiry card.

Pressure Cell for use as an accessory for maker's infrared analytical instruments is available in two standard lengths of 60 mm and 5 to 10 mm; enables gas and liquid samples to be run at high temperatures.—Instruments Div., Perkin-Elmer Corp., Norwalk, Conn.
For more information circle **471** on inquiry card.

Teflon Tubing. New Polypenco thin-wall Teflon tubing in sizes of ⅛" to 1" ID is available in ten coded colors for circuit identification. Teflon is non-corrosive, fungus resistant and has excellent outdoor life.—The Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa.
For more information circle **472** on inquiry card.

Xenon Thyratron. New 7086, for industrial applications, is a 3-electrode forced-air-cooled xenon thyratron having a negative-control characteristic, high commutation factor, and relatively short deionization time.—Electron Tube Div., Radio Corp. of America, Harrison, N. J.
For more information circle **473** on inquiry card.

Sheetmetal Conduit Template. New No. 48, in a scale of ¼" = 1 foot,

covers all sizes between 4" and 48" cross-sections, either round or square. —Rapidesign, Inc., P. O. Box 429, Burbank, Calif.

For more information circle **474** on inquiry card.

Thermometer. New model of Pyrocouple is available in four ranges and two basic styles: (1) remote-probe having probe mounted on end of a 30" flexible cable; (2) having probe mounted integrally on rear of indicating instrument.—Royco Instruments, 722 Arthur St., Albany 10, Calif.

For more information circle **475** on inquiry card.

Lab Furnace. New LAByrinth low-cost 3200°F furnace burns any available fuel gas and air. Charge space is 4½" (max) dia by 2¾" (max). Instantly transformed to a 2800°F (1538°C) unit with room for a 4"-dia by 5"-high charge.—Selas Corp. of America, Dresher, Pa.

For more information circle **476** on inquiry card.

Electrical Tachometer. New Speedvolter not only measures speed but enables trouble-shooting equipment by voltage and resistance checks.—Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.

For more information circle **477** on inquiry card.

Magnetic Particle Inspection Supplies. New complete line of supplies for all makes of magnetic particle inspection instruments includes colored and fluorescent pastes and powders; blowers and dispensers; inspection tapes, tags, etc.—Sonoflux, P. O. Box 14543, Houston 21, Texas.

For more information circle **478** on inquiry card.

Sealed Thermostat. New Klixon 20220 for refrigeration and air conditioning units is a disc type sp-st unit with automatic reset at fixed temperature settings; rated 25 amp non-inductive, 120/240 vac for 100,000 cycles.—Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

For more information circle **479** on inquiry card.

Cooking-utensil Thermostat. New adjustable and highly sensitive Ampli-TUBE rod and tube thermostat, rated at 1650 watts, resistive, 120/240 vac, is supplied with or without cord set and plug assembly to enclose thermostat.—Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

For more information circle **480** on inquiry card.

Transistors. Two new 4-watt diffused-base n-p-n silicon transistors close the gap between commercially-available low-power and high-power transistors; feature a typical saturation resistance of only 20 ohms at 25°C plus an operating range of —65°C to 200°C.—Texas Instruments, Inc., P. O. Box 312, Dallas, Texas.

For more information circle **481** on inquiry card.

Molded Black Nylon Screws. New 2-56 round-head screw precision-molded to AST specs, especially suitable for subminiature assemblies.—Weckesser Co., Dept. IUP, 5701 Northwest Highway, Chicago 30, Ill.

For more information circle **482** on inquiry card.

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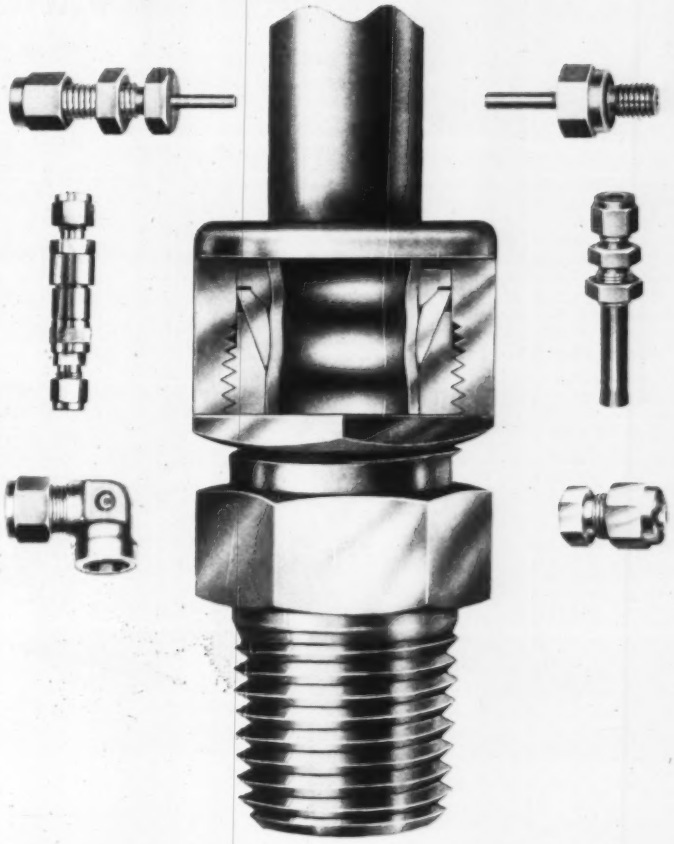

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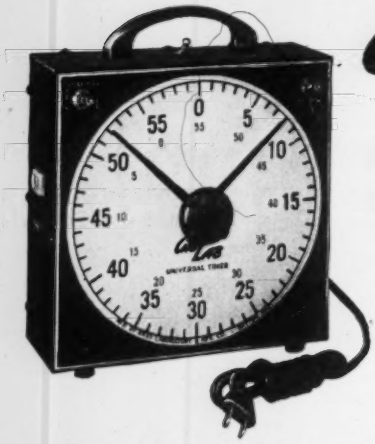

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New Plants and Mergers

CLIFTON PRECISION PRODUCTS has completed arrangements for purchasing a new 33,000-sq-ft facility at Colorado Springs.

REEVES SOUNDCRAFT CORP. announces plans for the world's first plant for the manufacture of magnetic tapes exclusively.

RADIATION COUNTER LABORATORIES, INC. will double the size of present facilities upon completion of a 6400-sq-ft addition.

ASSEMBLY PRODUCTS, INC. announces a 2000-sq-ft addition to their Palm Springs subsidiary plant.

TEXAS INSTRUMENTS opened a new plant in Bedford, England, the first manufacturing facility of the company outside the U. S.

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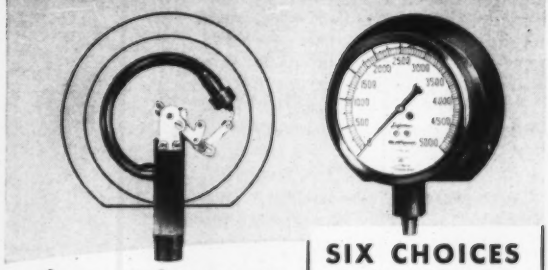

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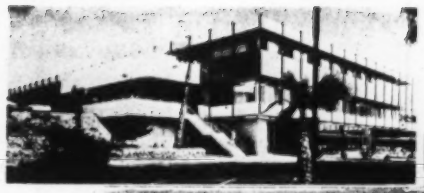
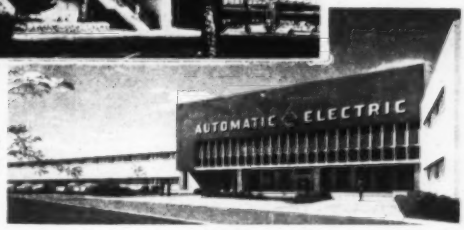


Helipot Div.



Automatic Electric

HELIPOT DIV. of Beckman Instruments has dedicated its new $3-million 156,000-sq-ft manufacturing plant in Newport Beach, Calif.

AUTOMATIC ELECTRIC CO. has dedicated its new 1,520,000-sq-ft plant at Northlake, Ill.

GRATON & KNIGHT announce purchase of Warren Belting Co., which will be operated as a new division.

PARKER APPLIANCE CO. has purchased the Hannifin Corp. and is changing the firm name to Parker-Hannifin Corporation.

NORDEN-KETAY announces two division expansions: a 31,000-sq-ft addition to the Precision Components Div. at Commack and a new 17,000-sq-ft building for its Gyromechanisms Div. at Huntington Station.

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Servonic "Model H" pressure transducers retain system simplicity and high electrical output, but they offer these operational extras . . .

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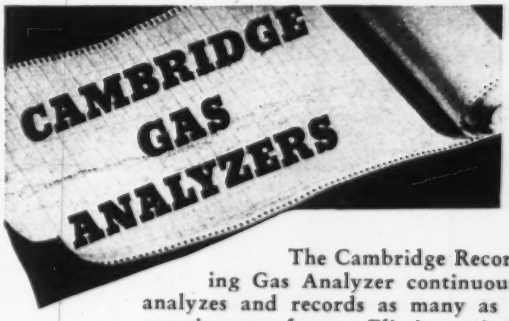

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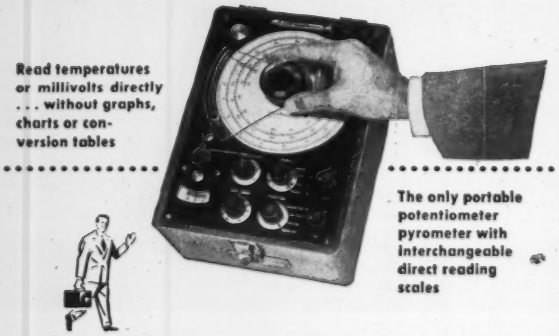

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People IN THE NEWS

K. Andersen

R. A. Schlegel

C. H. Barnard

Kenneth Andersen, executive vice president, SCIENTIFIC APPARATUS MAKERS ASSOCIATION, and prominent in the trade association profession throughout the country, is newly elected president of the AMERICAN SOCIETY OF ASSOCIATION EXECUTIVES.

DAYSTROM, INC. has named *Russell A. Schlegel* general manager of the newly formed Daystrom-Weston Industrial Division to be located at Poughkeepsie, N. Y.

BAILEY METER COMPANY announces appointment of *C. H. Barnard* as sales manager, industry div.; *W. E. Dueringer*, sales manager, Cleveland operations; *L. F. Richardson*, district operations sales manager.

TEXAS INSTRUMENTS INC. has appointed *Robert W. Olson* vice president-research and engineering and *E. O. Vetter* general manager-Industrial Instrumentation div.

MANNING, MAXWELL & MOORE, INC. announces *Arthur W. Johnson* as manager Ashcroft Gauge Products, *Jack E. Cox* as manager Consolidated Safety Valves, and *William H. Bolin* as manager product planning, Consolidated Ashcroft Hancock Div.

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T. M. Fitzgerald

R. E. Hadady

J. Cummins

MALLORY ELECTRONIC DIV., MALLORY & CO. INC., has named *T. M. Fitzgerald* general sales manager, assisted by *B. W. Chandler* as Eastern regional sales manager and *R. H. Andrew* as Central regional sales manager.

CONSOLIDATED ELECTRODYNAMICS CORP. appointed new divisional advertising managers: *Paul N. Bartness* for the Systems and Transducer Div.; *S. Frank Buck* for DataTape and Central Mfg. Div.; and *Thomas H. O'Connor* for the Datalab, Alectra, Glendale, and Analytical and Control Instrument divisions. *R. E. Hadady* was appointed sales manager of DataTape.

ATLAS PRECISION PRODUCTS CO., DIV. of Prudential Industries, Inc., announces appointment of *Jerry Cummins* as general sales manager.

GENERAL PRECISION EQUIPMENT CORP. has promoted *Dr. Raymond L. Garman* from technical director and chairman of the board of General Precision Lab. to vice president engineering and research of the corporation.

ESS INSTRUMENT CO. has appointed *Eugene Ross* sales manager.

TENSOLITE INSULATED WIRE CO. has appointed *Jack L. Shafer* vice president in charge of sales.

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*CORNING 707
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**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
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POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
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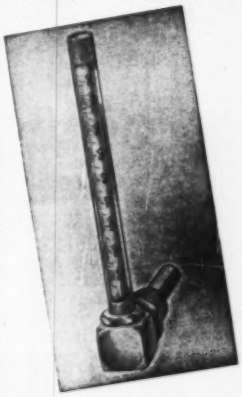

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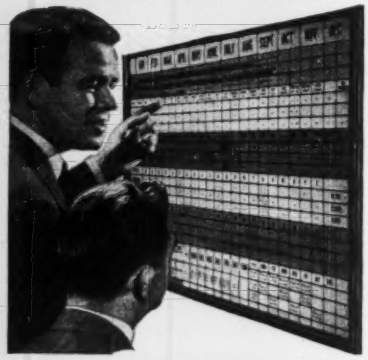

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New Literature

AUTOMATION

PROCESS CONTROL INSTRUMENTS. Series A-801 consists of four bulletins presenting full details of the completely Unitized Autronic instrument line for indicating, recording and controlling temperature, pressure, level flow, pH, etc.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle **501** on inquiry card.

TEXTILE PROCESS INSTRUMENTS. 64-page binder "Slasher & Size Room Controls Manual" describes systems for control of temperatures of size cooking and storage kettles, size boxes, overwaxers and slashers; also level control systems for size boxes and cookers.—The Power Regulator Co., 3400 Oakton St., Skokie, Ill.

Circle **502** on inquiry card.

BAG FILLER. 2-page Product Data Sheet 5702 describes Impacker model G-73 for automatic packing of feeds into bags.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **503** on inquiry card.

NUMERICAL CONTROL. 2-page Bulletin SM57 describes numerical control of production parts in automated production-assembly lines through use of an automatic marking machine.—New Method Steel Stamps, Inc., 147 Jos. Campau St., Detroit 7, Mich.

Circle **504** on inquiry card.

ENGINEERING AND MFG. SERVICES from small machine parts to complete designing, building and testing of special machinery and electronic equipment are described in new 4-page illustrated brochure.—Associated Engineers, Inc., P. O. Box 1628, Springfield, Mass.

Circle **505** on inquiry card.

MOTORS, SERVOS

ROTATING COMPONENTS. Data Sheets 866, 869 and 872, each 2 pages, cover servomotor-rate generators with linear output.—Beckman/Helipot Corp., Newport Beach, Calif.

Circle **506** on inquiry card.

SYNCHROS, ETC. 18-page binder-style catalog presents precision synchros, resolvers and rotating components.—Induction Motors of Calif., 6058 Walker Ave., Maywood, Calif.

Circle **507** on inquiry card.

VALVES, ACTUATORS

VALVE ACTUATOR. Four-page Application Bulletin No. 38.3 describes Model RF-697 Electrohydraulic Valve Actuator which operates from low-level dc or ac commands.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

Circle **508** on inquiry card.

SOLENOID VALVES. Four page condensed Bulletin VS-51 provides information on company's complete product line of solenoid valves and electromagnetic controls.—Automatic Switch Co., Florham Park, N. J.

Circle **509** on inquiry card.

REDUCING AND REGULATING VALVES. Four-page Section 1 describes new Cash-Acme regulators for hot or cold water and air; discusses applications; describes repair kits, etc.—A. W. Cash Valve Mfg. Corp., Decatur, Ill.

Circle **510** on inquiry card.

CONTROL VALVES. Six page Catalog 307 covers Series 30 balanced single-seated tight-closing diaphragm-operated valves; also pressure and temperature pilots.—Schade Valve Mfg. Co., 2527-37 N. Bodine St., Phila. 33, Pa.

Circle **511** on inquiry card.

TEMPERATURE

THERMOSTATS. Two-page Bulletin DD-THSN-21 covers Series 20220 sealed disc-type thermostats for appliances. Four page Bulletin AMTU-4 describes Series C9192 Ampli-TUBE adjustable thermostats for table appliances, hospital equipment, ovens, etc.—Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

Circle **512** on inquiry card.

THERMOCOUPLES. Four-page Bulletin 3.8 describes swaged magnesia-insulated thermocouple assemblies.—Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.

Circle **513** on inquiry card.

THERMISTORS, VARISTORS, etc. 20-page Technical Catalog covers thermistors, varistors, gas analysis cells, thermistor hypodermic needles, assemblies, kits, etc.—Victory Engineering Corp., Springfield Rd., Union, N. J.

Circle **514** on inquiry card.

FLOW, LEVEL

FLOW-RATE INDICATION Four page Bulletin M-1 describes 24 types of rotameters and two types of flow indicators.—Schutte and Koerting Co., Instrument Div., Cornwells Heights, Bucks County, Penna.

Circle **515** on inquiry card.

FLOW-RATE. Sixteen-page Catalog 1 presents all forms of primary ele-

ments made by company, including fabricated venturi tube and fabricated flow nozzles.—Burgess-Manning Co., Penn Instruments Div., 4110 Haverford Ave., Phila. 4, Pa.

Circle **516** on inquiry card.

FLOW-RATE CONTROL. Twelve-page Bulletin 900 on Type S controller deals with water usage and its conservation.—Simplex Valve & Meter Co., Lancaster, Penna.

Circle **517** on inquiry card.

LIQUID LEVEL GAGES AND VALVES. 8-page complete condensed Catalog No. 305 includes pressure-temperature graphs and ratings, materials, and tables.—Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

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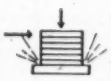

WEIGHT, FORCE, PRESSURE

ELECTRIC WEIGHING. Six-page bulletin, "The Way to Weigh," covers principles and applications of Ametron Electronic Weighing Systems.—Streeter-Amet Co., Grayslake, Ill.

Circle **519** on inquiry card.

LOAD CELL. Two page Engineering Bulletin MB-1 describes Type B monoaxial load assembly for quantitative measurement of off-axial thrust components.—Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.

Circle **520** on inquiry card.

VACUUM GAGE. 24-page Bulletin 9-1 describes five types of high-vacuum gages; gives their characteristics and applications.—Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Circle **521** on inquiry card.

PRESSURE AND DRAFT GAGES. Eight-page Bulletin MSP-134 describes the MP Indicator, a multipoint instrument for measuring draft, pressure, and differential, employing an extremely sensitive, yet sturdy bellow-type diaphragm for scale ranges from 0 to 40" of water. For pressures exceeding this, helical elements are employed.—Hagan Chemicals & Controls, Inc., 323 Fourth Ave., Pittsburgh 30, Pa.

Circle **522** on inquiry card.

PRESSURE AND VACUUM. General Instrument Catalog is a binder containing ten 4-page Technical Publications on barometers, absolute pressure gages, manometers, manostats, variometers and recorders.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

Circle **523** on inquiry card.

CAPSULAR ELEMENTS. 2-page brochure describes metallic pressure-sensing diaphragms of high stability.—Bellofram Products Corp., Blanchard Rd., Burlington, Mass.

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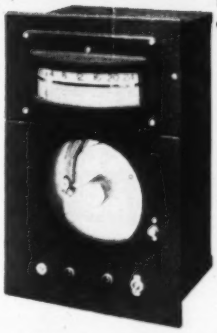

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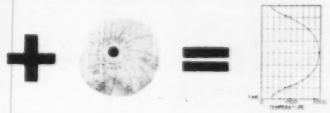

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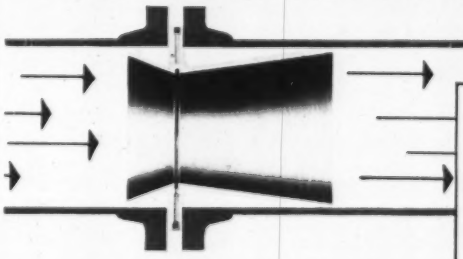

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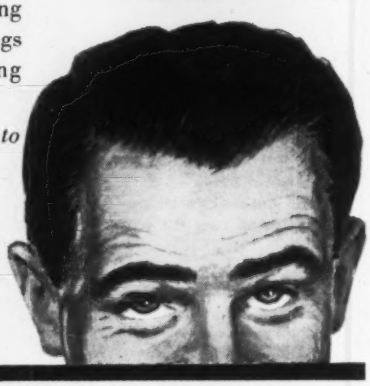

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For more information circle **139** on inquiry card.

NEW LITERATURE

MANOMETER PROTECTION. 2-page bulletin describes new Mercureceiver which prevents loss of mercury and makes possible steady average pressure readings.—Chemiquip Co., 460 West Broadway, New York 12, N. Y.

Circle **525** on inquiry card.

TIME, SPEED, COUNT

SPEED MEASUREMENT. Eight catalog pages constitute a binder designated GET-2741 (1,2,3,4.) which describes four methods of measuring speed to 0.1% accuracy.—General Electric, Schenectady 5, N. Y.

Circle **526** on inquiry card.

TIMER, INTEGRATOR, TENSILE TEST. —Two 2-page Instrument Sheets describe 18 electrical and mechanical instruments, including high-rate tensile testers, strain-gage calibrators, etc.—Allegany Instrument Co., Inc., 1091 Wills St., Cumberland, Md.

Circle **527** on inquiry card.

ELECTRIC COUNTERS. Two 4-page technical bulletins, E 13 and E 28, describe use of electric impulse counters in combination with transistors and in conjunction with electronic tubes. Six-page Bulletin E 19 describes SODECO one-decade impulse counter, Type 1TD.—Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

Circle **528** on inquiry card.

AUTOMATIC TIMER. Two-page Bulletin RC300 describes new precision interval timer, of repeat-cycle type, with three switches and intercam reduction, featuring vernier calibration. —The A. W. Haydon Co., Waterbury, Conn.

Circle **529** on inquiry card.

TIMERS, RELAYS. Two page bulletin describes Tally-Print, Time Recorder Totalizer, Robot-Eye, Rev-Switch etc. —Standard Instrument Corp., 657 Broadway, New York 12, N. Y.

Circle **530** on inquiry card.

HUMIDITY, AIR

DEHUMIDIFIERS. Binder of data sheets, etc., entitled "Moisture, the Industrial Fifth Column," describes Driline Pressure Dehumidifiers. 16-page brochure No. DS-1 is a treatise "Dehumidified Storage" describing various methods of removing moisture from air.—Desomatic Products, Inc., 1109 W. Broad St., Falls Church, Virginia.

Circle **531** on inquiry card.

PURE AIR. Four page bulletin discusses applications of Kathabar systems which kill over 97% of microorganisms in large volumes of air.—Air Conditioning and Drying Div., Surface Combustion Corp., Toledo 1, Ohio.

Circle **532** on inquiry card.

ANALYTICAL, LABORATORY

CHROMATOGRAPHS. Three new 2-page sheets on gas chromatographs and accessories describe (1) low-

temperature GC-1 (No. 728); (2) high-temperature GC-2 (No. 715-A); and (3) complete line of sampling accessories and column information (No. 727).—Beckman/Scientific, Fullerton, Calif.

Circle **533** on inquiry card.

MASS SPECTROMETER. 9-page Bulletin MS-5 describes three models of Time-of-Flight Mass Spectrometer.—Bendix Aviation Corp., Cincinnati Div., 3130 Wasson Rd., Cincinnati 8, Ohio.

Circle **534** on inquiry card.

ULTRACENTRIFUGATION. 8-page Form SBE-20 describes the various rotors and their cells and accessories for analytical ultracentrifugation.—Spinco Div., Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto, Calif.

Circle **535** on inquiry card.

ANALYZER. Six-page technical description of Argon Purity Analyzed utilizing thermal conductivity principle to assure 99.999% product purity.—Thermco Labs., Johnson Rd., Michigan City, Ind.

Circle **536** on inquiry card.

X-RAY SPECTROGRAPH. 8-page booklet RC-211 describes improved Norelco Autrometer, automatic indexing X-ray spectrograph. Twelve-page booklet gives engineering data on newest x-ray instruments for element analysis and structure determinations.—Instrument Div., Philips Electronics, Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **537** on inquiry card.

CARBON AND SULFUR ANALYSIS. Twelve-page Bulletin 104 is a catalog of items used for all types of carbon and sulfur analysis apparatus.—Accessories are described in 4-page brochure.—Laboratory Equipment Corp., St. Joseph, Mich.

Circle **538** on inquiry card.

ADSORBENTS. Four-page Bulletin 835 is a guide and price list covering packaged adsorbents for use in all chromatographic instruments.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **539** on inquiry card.

OVENS, FURNACES, ETC. 48-page two-color miniature Catalog No. M-57 covers complete line of electric ovens, furnaces, Magni-Whirl water and oil baths, enviromental cabinets and controlled-temperature equipment. 4-page Bulletin No. 5510-A on temperature control equipment features Power-O-Matic Industrial Batch Ovens.—Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

Circle **540** on inquiry card.

LAB EQUIPMENT. 16-page Vol. 9 No. 1 of Lanco Apparatus News features thermostats and heaters, Sartorius Selecta Balance; describes 28 other items; includes a 4-page removable centerspread or all Beckman pH electrodes.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

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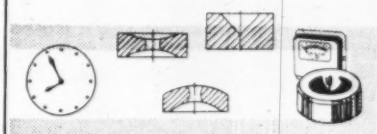

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NEW LITERATURE

FLUID DISPENSER. 2-page Newsletter No. 36 describes Corinth Finger-Tip Fluid Dispenser.—Gardner Laboratory, Inc., P. O. Box 5728, Bethesda 14, Md.
Circle **542** on inquiry card.

LAB EQUIPMENT. 12-page Number 14 of "Laboratory Spotlight" describes twelve types of instruments; features new Cahn Electro-balance and new Beckman gas Chromatograph.—Harshaw Scientific, Div. of the Marshaw Chemical Co., Cleveland 6, Ohio.
Circle **543** on inquiry card.

INCUBATORS. Two page Bulletin S6111-1 describes Models 3630 and 3640 anaerobic incubators featuring accurate control of gases and variable pressures.—National Appliance Co., 7634 S. W. Capitol Hwy., Portland 19, Ore.
Circle **544** on inquiry card.

PLASTIC LAB SUPPLIES. Sixteen-page Catalog F 957 covers a wide variety of supplies made of polyethylene, polyurethane, polyvinyl and Nylon.—Wisconsin Science Supply Co., 1419 Underwood Ave., Milwaukee 13, Wis.
Circle **545** on inquiry card.

TEFLON LAB WARE. Four-page bulletin is a condensed catalog of Teflon sheets, tubings, rods, flasks, cans, pails, etc.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.
Circle **546** on inquiry card.

OPTICAL

OPTICAL COMPARATORS. 40-page Catalog 5700 is virtually a handbook of technical information on projection-type optical comparators, their construction and uses, fixtures, standard and special charts, accessories, lens data and specs.—Jones & Lamson Machine Co., Springfield, Vermont.
Circle **547** on inquiry card.

CATHETOMETER. 2-page Bulletin 194-57 describes new coordinate cathetometer which reduces measuring time and setting errors by 50%.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.
Circle **548** on inquiry card.

OPTICAL MEASURING. Six-page leaflet contains basic and fundamental information for purchasers of precision measuring instruments.—Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.
Circle **549** on inquiry card.

INK PHOTOMETER. Two-page Number 25 of Gardner Lab Newsletter describes new ink photometer for determining irregular areas that provide photographic contrast, such as maps, printed circuits, etc.—Gardner Laboratory, Inc., Bethesda 14, Md.
Circle **550** on inquiry card.

SCIENTIFIC PHOTOGRAPHY. 12-page Technical Bulletin 57 is a binder-style

catalog of film transports and viewers, projectors, animation camera motor, etc.—Richardson Camera Co., 171 W. Magnolia Blvd., Burbank, Calif.

Circle **551** on inquiry card.

COLOR MATCHING. Four-page Bulletin 262, titled "Color Sells—Yes," contains charts and other technical data showing how and why of Day-lighting.—Dept. P. 10, Macbeth Corp., Newburgh, N. Y.

Circle **552** on inquiry card.

DATA HANDLING

AUTOMATIZED PLOTTING. Extra-large folder, Bulletin DPL-115 describes "Dataplotter," said to be the first commercial electronic device which converts digital point data into accurate continuous-line presentations; contains four 11" x 17" graphs.—Electronic Associates, Inc., Long Branch, N. J.

Circle **553** on inquiry card.

MEMORY UNITS. Four-page bulletin describes several models of magnetic storage drums.—Bryant Chucking Grinder Co., P. O. Box 620, Springfield, Vermont.

Circle **554** on inquiry card.

TAPE PUNCH. 4-page Form 1600-A describes new ComptoTape which automatically produces a punched tape as a by-product of a normal comptometer computation or vertification operation.—Comptometer Corp., 1735 North Paulina St., Chicago 22, Ill.

Circle **555** on inquiry card.

NUCLEONICS

REACTOR SUPPLIES. Two-page technical bulletin, "Fuel Strip for Critical Assemblies," and 8-page brochure, "Nuclear Products: Cores, Fuel Elements, Components."—Nuclear Products Div., Metals & Controls Corp., Attleboro, Mass.

Circle **556** on inquiry card.

VERSATILE SCALER. Two-page catalog sheet describes new Model 210 with fast resolving time of 0.8 microseconds, permitting counting rates of a million counts per minute.—Radiation Instrument Development Laboratory, 5737 S. Halsted St., Chicago 21, Ill.

Circle **557** on inquiry card.

NUCLEAR RADIATION TESTING. Four page folder describes services, facilities, and staff activities of company's Nuclear Radiation Laboratory.—Admiral Corp. Nuclear Radiation Lab., 3800 Cortland St., Chicago 47, Ill.

Circle **558** on inquiry card.

MICRORADIOGRAPHY. Folder on projection microradiography contains photos and micrographs which illustrate the new instrument and its application.—Instruments Div., Philips Electronics, Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

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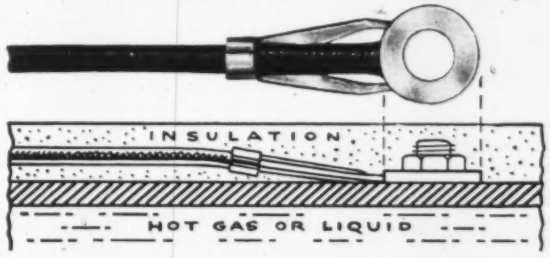

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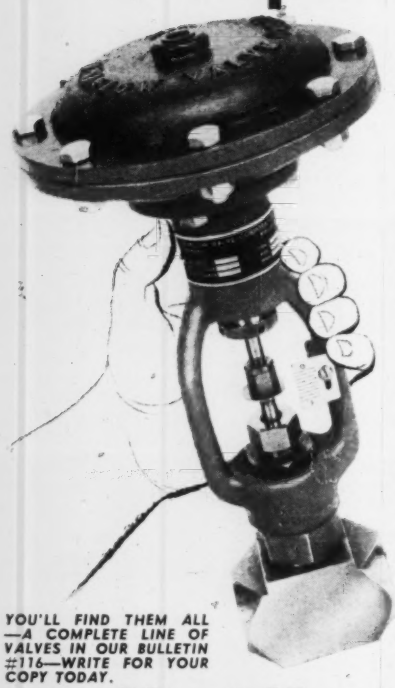

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NEW LITERATURE

RECORDERS

MINIATURE RECORDER. Two-page bulletin describes new Series 663 Dynamaster, said to be the first true motor-driven self-balancing electronic instrument in miniature size.—The Bristol Co., 113 Bristol Rd., Waterbury 20, Conn.

Circle **560** on inquiry card.

PHOTOGRAPHIC PAPERS. 12-page Form 32 describes photographic papers and chemicals, explains use of various types of papers and processing combinations.—The Haloid Co., Rochester 3, N. Y.

Circle **561** on inquiry card.

OSCILLOGRAPHS. Sixteen-page catalog contains descriptions, specifications and prices of all "150" oscillographic recording systems and full line of "150" accessories and unit instruments.—Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.

Circle **562** on inquiry card.

TESTING, GAGING, INSPECTING

TEST CHAMBERS. 2-page Catalog sheet covers altitude chambers, dry-ice and high-temperature chambers, rain & sunshine test chambers, etc. —Environmental Equipment Co., 371 Linden St., Brooklyn 27, N. Y.

Circle **563** on inquiry card.

CONCRETE AND SOIL TESTING APPARATUS. Two-page bulletin describes new Pavement Detector, new concrete Kelly Ball, new low-cost air indicator, and direct reading penetrometer.—Soiltest, Inc., 60 East 42nd St., New York 17, N. Y.

Circle **564** on inquiry card.

DIAL INDICATOR. 28-page Bulletin titled "Dial Indicator Service Manual and Parts List" is aimed at users who prefer to do their own servicing; includes large exploded views.—Standard Gage Co. Inc., 70 Parker Ave., Poughkeepsie, N. Y.

Circle **565** on inquiry card.

SURFACE FINISH. 14-page Catalog 157 features Profilometer Group II comprising QA Amplimeter, V Mototrace, BK Linkarm and LJ Tracer.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **566** on inquiry card.

ELECTRONIC GAGE. 4-page Engineering Data Bulletin IG-001 describes a new type of electronic dimensional gage called the "Versachek."—The Taft-Pierce Mfg. Co., Woonsocket, R. I.

Circle **567** on inquiry card.

TORQUE WRENCH CALIBRATOR. Two-page Bulletin 210 describes six models of calibrator for torques from

0-200 oz-in to 0 to 2000 lb-ft.—Skidmore-Wilhelm Mfg. Co., 442 Green Road, Cleveland 21, Ohio.
Circle **568** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

FREQUENCY MEASUREMENTS. Four-page technical data bulletin describes new Model 7700 Microsensitive Frequency Measuring System for detecting and measuring radiated signals in range 0.54-30.5 Mc.—Dept. 79, Beckman/Berkeley, 2200 Wright Ave., Richmond 3, Calif.
Circle **569** on inquiry card.

WIDE-BAND AMPLIFIERS. 4-page short-form catalog presents latest in wide-band amplifiers.—Instruments for Industry, Inc., 150 Glen Cove Rd., Mineola, L. I., N. Y.
Circle **570** on inquiry card.

CONSTANT-CURRENT CONVERTERS. Bulletins 957 and B957 describe unique current governors for constant current from 1 ma to 30 amps.—North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, N. Y.
Circle **571** on inquiry card.

PANEL INSTRUMENTS. Four page Catalog P-22 shows latest styles and ranges of panel meters in sizes from 2⅛" to 7¼", features three new modern clear plastic models.—Ideal Precision Meter Co., Inc., 126 Greenpoint Ave., Brooklyn 22, N. Y.
Circle **572** on inquiry card.

ELECTRONIC EQUIPMENT. Eight-page catalog covers meter calibrators, voltage regulators, digital readout meters, dc power supplies, etc., for lab or production.—Davenport Mfg. Co., Dept. IAP, 1713 No. Ashland Ave., Chicago 22, Ill.
Circle **573** on inquiry card.

CIRCUIT ANALYZERS. Sixteen-page catalog describes a complete line of automatic circuit analyzers used in aircraft and missile manufacturing and testing.—Electronics Division, DIT-MCO, Inc., 911 Broadway, Kansas City 5, Missouri.
Circle **574** on inquiry card.

FIELD-STRENGTH METER. Eight-page bulletin describes new Model FSM-1 VHF field strength meter which tunes continuously through frequency range from 54 to 216 Mc to supply direct voltage readings from 10 microvolts to 3 volts.—Blonder-Tongue Laboratories, Inc., 9-25 Alling St., Newark 2, N. J.
Circle **575** on inquiry card.

ELECTRONIC TEST INSTRUMENTS. New 8-page composite test equipment catalog, Form SM-31, lists 24 items including two new color generators and new Cardmatic Automatic Tube Tester.—The Hickok Electrical Instrument Co., 10519 Dupont Ave., Cleveland 8, Ohio.
Circle **576** on inquiry card.

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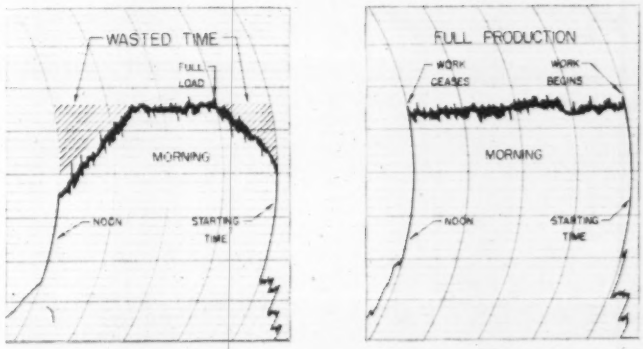

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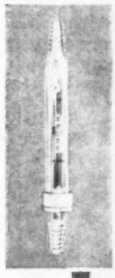

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NEW LITERATURE

ELECTRICAL TESTING. Four-page Bulletin No. AP10 covers scanners, tube checkers, and specialized instruments for industrial and service shop use.—B&K Mfg. Co., 3726 Southport Ave., Chicago 13, Ill.

Circle **577** on inquiry card.

FAST PULSE TRANSMISSION EQUIPMENT. 5-page catalog describes coaxial cables prefabricated to any desired length with any desired standard connectors, terminations, etc.—Electrical and Physical Instrument Corp., 42-19 27 St., Long Island City 1, N. Y.

Circle **578** on inquiry card.

ELECTRONIC CONTROL. Twelve-page bulletin, "Industrial Electronics for You," covers company's complete line of electronic equipment for automatic control in industry, including welding control.—Robotron Corp., 21300 W. Eight Mile Rd., Detroit 19, Mich.

Circle **579** on inquiry card.

PANORAMIC TECHNIQUES. 4-page Vol. 1 No. 1 of "The Panoramic Analyzer" deals with frequency analysis of vibration and noise, contains no advertising.—Editor, The Panoramic Analyzer, 520 S. Fulton Ave., Mount Vernon, N. Y.

Circle **580** on inquiry card.

MOBILE RADIO. Forty-page brochure ECR-497 on two-way mobile radio equipment shows wide range of equipment designed to fit individual needs based on preset FCC rulings.—General Electric, Communication Products Dept., Syracuse, N. Y.

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Q A

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BOX NO. 351

POWER SUPPLIES

POWER SUPPLIES. 8-page Bulletin EV-235 describes constant voltage dc power supplies for intermittent, variable, pulse or high-current loads.—4-page Bulletin DC-245 describes new dc "Solavolt" adjustable constant-voltage dc supply recommended for experimental work on relay circuits.—Sola Electric Co., 4633 West 16th St., Chicago 50, Ill.

Circle **582** on inquiry card.

POWER SUPPLIES. Six-page Supplement 2 Catalog 57 announces new 1.5-amp models of power supplies available in 3 voltage ranges.—Lambda Electronics Corp., 11-11 131 Street, College Point 56, N. Y.

Circle **583** on inquiry card.

VOLTAGE-REGULATED DC POWER SUPPLY. Two-page Bulletin No. 250 describes new Model TM25, a tubeless lab type with a continuous duty rating of 0-150 vdc at 2 amp. Voltage regulation is held to plus or minus 1% and ripple is less than 0.03% of the average dc at maximum output.—Opad Electric Co., 69 Murray St., New York 7, N. Y.

Circle **584** on inquiry card.

INDUSTRIAL RECTIFIERS. Four-page Bulletin IR-1 describes selenium, germanium and silicon dc power supplies for cathodic protection, battery charging, magnetic chuck and dc motor control.—Rapid Electric Co., 2881 Middletown Rd., Bronx 61, N. Y.

Circle **585** on inquiry card.

TUBES, TRANSISTORS

TRANSISTORS. Two-page Bulletin DL-S-840 gives tentative specs, graphs, etc., of new Types 2N497 and 2N498 n-p-n diffused junction silicon transistors.—Texas Instruments Inc., P. O. Box 312, Dallas, Texas.

Circle **586** on inquiry card.

GERMANIUM COMPONENT RECTIFIERS. Six-page Bulletin GEA-5773C tells how to select and apply fan-cooled and blower-cooled germanium rectifiers, gives operating characteristics, ratings, etc.—General Electric Co., Schenectady, N. Y.

Circle **587** on inquiry card.

DIODES. Two-page Bulletin SR-155 describes new 1-watt and 3.5-watt silicon Zener diodes for high-temperature applications.—International Rectifier Corp., El Segundo, Calif.

Circle **588** on inquiry card.

TRANSISTORS. 6-page Bulletin G-120 describes GT's line of pnp and npn transistors; also transistor radio kits with accompanying circuit diagrams.—General Transistor Corp., 91-27 138th Pl., Jamaica 35, N. Y.

Circle **589** on inquiry card.

INDUSTRIAL TUBES. 6-page Form NH73 is a guide to replacement of various manufacturers' type numbers with Sylvania industrial electron tubes.—Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Circle **590** on inquiry card.

SILICON DIODES for high temperature and power rectifiers are described in new 12-page Bulletin PC-14—United States Dynamic Corp., 1250 Columbus Ave., Boston 20, Mass.

Circle **591** on inquiry card.

ELECTRON TUBES. Two 4-page catalog sections. One describes new 3BU8 and 6BU8 sharp-cutoff twin pentodes; the other describes new 6973 miniature beam power tube.—Tube Div., Radio Corp. of America, Harrison, N. J.

Circle **592** on inquiry card.

INDUSTRIAL THYRATRON. Twelve-page brochure fully describes No. 7086 xenon thyratron, negative-control triode type.—Electron Tube Div., Radio Corporation of America, Harrison, N. J.

Circle **593** on inquiry card.

RELAYS, SWITCHES

LIMIT SWITCH. Four-page Bulletin 20 announces new "Plug-in Limit," which can be replaced in seconds, describes all five actuator types.—Micro Switch Div., Freeport, Ill.

Circle **594** on inquiry card.

RELAYS. 20-page catalog covers complete line of magnetic relays including sensitive, subminiature, telephone, antenna, latching, time delay and polar types.—Kurman Electric Co., Div. of Norbute Corp., 191 Newel St., Brooklyn 22, N. Y.

Circle **595** on inquiry card.

RELAYS. Two 2-page technical bulletins describe E410 general-purpose and E410LL dry-circuit relays, both 4-pole double-throw ac or dc, featuring balanced armatures for versatility.—Electro Mechanical Specialties Co., Inc., 1016 N. Highland Ave., Los Angeles 38, Calif.

Circle **596** on inquiry card.

RELAYS, CONTROLS, ETC. Twelve-page pocket folder entitled "Check List of Reliable Controls" summarizes information about "Diamond H" relays, thermostats, rotary switches, range switches, motor controls and "snap-ins."—The Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.

Circle **597** on inquiry card.

RESISTORS, POTENTIOMETERS

VOLTAGE DIVIDER. Four-page Data Sheet 54-99 covers complete details of new Series 5000 ½" single-turn precision potentiometer.—Helipot Corp., Div. of Beckman Instruments, Inc., Newport Beach, Calif.

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RESISTANCE ELEMENTS. Sixteen-page booklet, "How to use Platinum Resistance Thermometers in Temperature Measurement, Telemetry, and Control," is said to be the first compilation of technical information on platinum resistance thermometers into a single booklet.—Trans-Sonics, Inc., Burlington, Mass.

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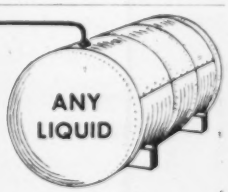

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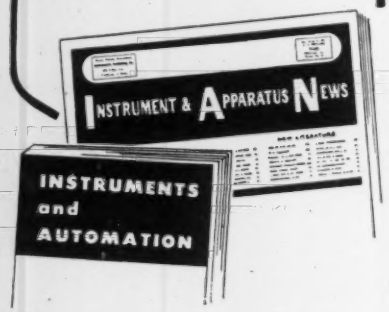

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NEW LITERATURE

CARBON-PILE RHEOSTAT ELEMENTS. Five page "Carboneering" Bulletin 6AE covers a wide range of carbon discs, plates and pile assemblies for all types of carbon pile rheostats and similar control units.—Speer Carbon Co., St. Marys, Penna.

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ELECTRICAL, ELECTRONIC COMPONENTS

HIGH-FREQUENCY CAPACITORS. Six-page Bulletin GEC-1346B describes class HF water-cooled units, discusses power factor improvement in circuits operating at frequencies from 500 to about 12,000 cps; includes performance data on 53 separate ratings. —General Electric Co., Schenectady 5, N. Y.

Circle **601** on inquiry card.

NYLON BOBBINS AND WASHERS. 4-page catalog outlines complete specifications on nylon bobbins and washers.—Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio.

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RF FILTERS. Four-page catalog lists RF suppression filters specifically designed for shielded enclosures and individual applications.—Axel Bros., Inc., Electronics Div., 134-20 Jamaica Ave., Richmond Hill 18, N. Y.

Circle **603** on inquiry card.

COLLECTOR RINGS. Four-page Bulletin 83 describes cylindrical style and annular style of custom-built collector rings; shows how to prepare data for estimating.—The B. A. Wesche Electric Co., 9027 Shell Rd., Cincinnati 36, Ohio.

Circle **604** on inquiry card.

CONNECTORS. Four-page Bulletin HYF-7 describes "Hyfen" solderless multi-lead plug-and-receptacle connectors.—Omaton Div. of Burndy Corp., Norwalk, Conn.

Circle **605** on inquiry card.

TERMINALS. Four-page brochure describes custom metallized hermetic terminals available from stock.—Mitronics, Inc., 1290 Central Ave., Hillside, N. J.

Circle **606** on inquiry card.

CONTACTS. Four-page brochure describes silver, silver-alloy and precious-metal electrical contacts; gives availability table of special and composite contacts; discusses design and specification stages.—Contacts Inc., 1100 Silas Deane Hwy., Wethersfield, Conn.

Circle **607** on inquiry card.

FABRICATION

TRANSFORMER & BOBBIN WINDER. Catalog page describes Model 149-AM heavy-duty transformer and bobbin winder handling wire sizes 4 to 23. —Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

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NEW LITERATURE

DIE CASTING. Four-page folder describes "Intercast" die-casting process for automatic production of small hinged or linked parts without subsequent assembly.—Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 609 on inquiry card.

SOLDER GUN. Two page Form No. 402 describes 150-watt Instant Solder gun and attachments.—Hexacon Electric Co., 161 West Clay Ave., Roselle Park, N. J.

Circle 610 on inquiry card.

DIALS, PANELS AND NAMEPLATES. Six-page Bulletin 10.30, titled "Idea File for Standards and Design Engineers," gives data for guidance in specs, on various marking techniques available, on various types of finishes and coatings as well as marking and luminous materials, etc.—United States Radium Corp., Morristown, N. J.

Circle 611 on inquiry card.

BELLOWS MAKING. Four page folder, entitled "A Proved Analytical Engineering Service Solves Complex Bellows Applications," describes facilities.—Metal Bellows Corp., 27 Mica Lane, Wellesley Hills 82, Mass.

Circle 612 on inquiry card.

MECHANICAL COMPONENTS

MECHANICAL COMPONENTS. 64-page miniature supplemental Catalog No. 13 covers precision gears and related products; lists over 2000 products.—PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 613 on inquiry card.

HAIRSPRINGS. 8-page brochure is a practical guide to materials and engineering calculations for hairsprings used in instruments, gear trains, clocks and other fine mechanisms.—Associated Spring Corp., F. N. Manross & Sons Div., Bristol, Conn.

Circle 614 on inquiry card.

O-RINGS. Eight-page Bulletin OR-57 lists standard O-rings keyed to the new uniform numbering system in accordance with SAE ARP 568, cross-referenced to sizes in 6227, 6230 and 629 series; also lists C/R compounds, hardness ratings, compatibility and temperature ranges.—Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago 22, Ill.

Circle 615 on inquiry card.

FASTENERS, ETC. Twenty-page Catalog 106 is virtually a condensed handbook on design and use of such cold-headed specialties as rivets, nails, screws, and other small parts.—John Hassall, Inc., Westbury, L. I., N. Y.

Circle 616 on inquiry card.

GEARS, REDUCERS, ETC. Six-page Brochure PG-100 covers precision gears, commercial gears, speed reducers and motorized reducers.—Grant Gear Works, Inc., 154 W. Second St., Boston 27, Mass.

Circle 617 on inquiry card.

LAMINATED PLASTICS. Six page folder describes the six most widely used grades of metal-clad laminates for printed circuitry use; contains detailed tables giving strengths, properties and dimensions.—Synthane Corp., Oaks, Penna.

Circle 618 on inquiry card.

CABLE RACES. Folder contains several sheets on troughs, channels and other cable-supporting equipment and accessories.—T. J. Cope Div., Rome Cable Corp., Collegeville, Penna.

Circle 619 on inquiry card.

PIPE, TUBING

FLEXIBLE TUBING. Two 2-page bulletins describe Teflon flexible tubing.—Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38th St., Phila. 4, Pa.

Circle 620 on inquiry card.

PVC PIPE. 32-page catalog covers polyvinyl chloride pipe, its properties, applications and installation techniques.—A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.

Circle 621 on inquiry card.

MISCELLANEOUS

CARD DISPLAYER. New 2-page bulletin and spec sheet describes Model 340 controlled-cycle card displayer with automatic/manual switch.—Hunter Mfg. Co., Inc., 108 North Linn St., Iowa City, Iowa.

Circle 622 on inquiry card.

ETCHED CIRCUITS. Eight-page brochure describes company's facilities for designing and producing etched wiring boards.—Bureau of Engraving, Inc., Industrial Div., 500 South 4th St., Minneapolis 15, Minn.

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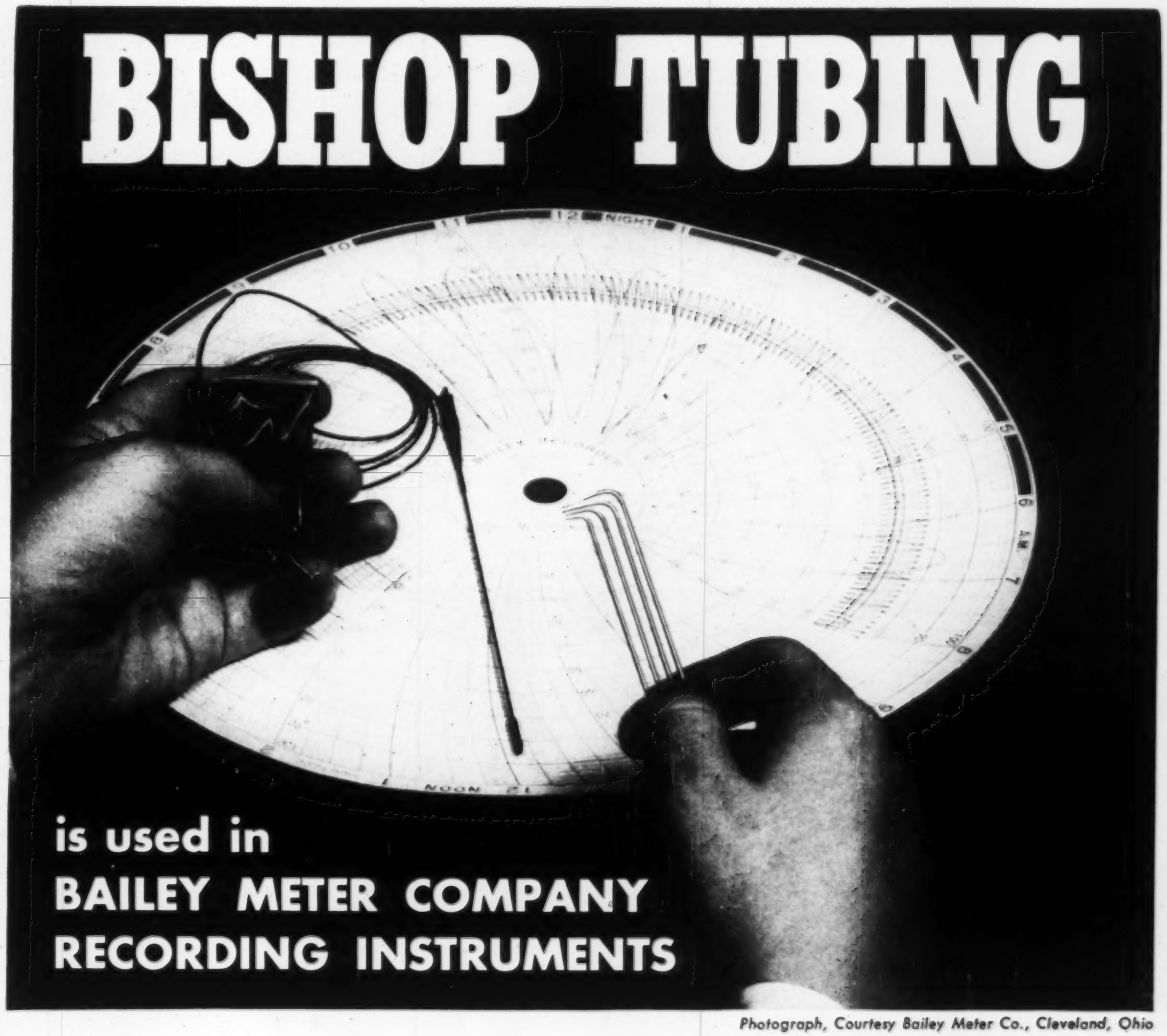

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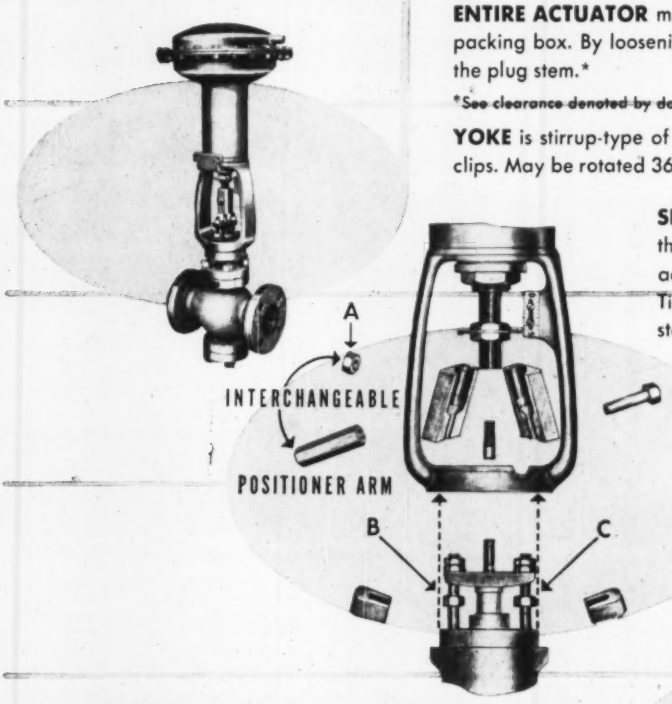

ENTIRE ACTUATOR may be removed and replaced without disturbing the packing box. By loosening nuts A, B, and C the actuator may be lifted over the plug stem.*

*See clearance denoted by dotted lines and arrows.

YOKE is stirrup-type of cast nodular iron. Held to bonnet by **stainless steel** clips. May be rotated 360° on bonnet.

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SLOTTED HOLDING CLIPS permit removal of clips without removing nuts B and C.

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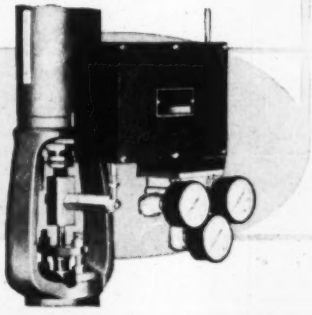

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